University of Alberta

Human Taphonomy: Khuzhir-Nuge XIV, Siberia and Edmonton, Alberta

by

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ABSTRACT

This study is an examination of cultural taphonomic processes at two sites: the cemetery site of Khuzhir-Nuge XIV (KN XIV) in the Baikal region of Siberia representing the prehistoric Early Bronze Age hunting-and-gathering Glazkovo culture (c. 3400–1700 BC) and the Ellerslie Biological Field Station (EBFS) in Edmonton, Alberta, where experimental research was performed. Experimental research was composed of animal analogy burials using domestic pigs (*Sus scrofa*) as models for humans.

Cultural taphonomic factors investigated at KN XIV and the EBFS include the mortuary use of fire, the mortuary use of red ochre, grave architecture, and grave disturbance particularly in the form of looting. Additionally, rates of decomposition using data from all the investigations listed above were compiled in the final study.

Significant findings include: 1) a better understanding of the mortuary use of fire, red ochre, grave disturbance and looting at KN XIV; 2) the technology of fire application and its corresponding effects on bone, specifically, the time and amount of heat it takes to significantly alter skeletal condition; 3) the important role animal scavenging plays when assessing the influence of various cultural taphonomic factors such as that caused by fire, grave architecture, looting, and the numerous processes associated with decomposition; and 4) the relatively short amount of time it takes to reach an advanced or skeletonized stage of decomposition in Edmonton, Alberta, given all the observed circumstances associated with decomposition rates.

This research expands the existing KN XIV data set by providing more potential taphonomic variables to be considered in relation to Glazkovo mortuary activities and boreal forest hunter-gatherer lifestyles in general. These variables may be important when assessing aspects of mortuary behavior or in the analysis of skeletal remains themselves. The results from this project also illustrate the kinds of information that can be learned about cultural processes from actualistic experiments and may be applied to taphonomic situations in other regions of both ancient and contemporary contexts.

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1. RESEARCH DESIGN

1.1 INTRODUCTION

This dissertation is an examination of cultural taphonomic processes at two sites: the Glazkovo cemetery site of Khuzhir-Nuge XIV (KN XIV) representing a prehistoric Early Bronze Age hunting-and-gathering Glazkovo culture (3400–1700 BC) in the Baikal region of Siberia and the Ellerslie Biological Field Station (EBFS) in Edmonton, Alberta, where experimental research was performed. The discipline of taphonomy was first introduced by Efremov (1940) as a new branch of paleontology that studies the transition of animal bodies from the biosphere to the lithosphere. The definition of taphonomy has since been expanded to include all palaeontological research that defines, describes, and systematizes the nature and effects of processes that act on organic remains after death (Gifford 1981). Human taphonomy focuses on the effect of those processes on human remains. These processes could result from characteristics of the human remains themselves, environmental or natural activity, or cultural activity.

The primary task of this research is to assess the impact of cultural alterations, which previously have not been given much attention in archaeological research. Cultural taphonomic factors are those characterizing human mortuary activity (Nawrocki 1995), for example cremation, mummification, and embalming or any other type of human activity that alters human remains after death including excavation and curation.

1.2 LITERATURE REVIEW

1.2.1 KHUZHIR-NUGE XIV SITE BACKGROUND

The Lake Baikal region of south-central Siberia has been inhabited for at least the last 40,000 years (Goebel and Aksenov 1995). The Neolithic in this region is characterized by the appearance of ceramics rather than its customary association with agriculture and sedentism (Chard 1974). The Early Bronze Age period is defined by the introduction of metal tools. Both periods are distinguished by a large number of cemeteries with well-preserved human remains and artifacts.

Since the Late Mesolithic, the region was inhabited successively by the Kitoi, Serovo/Isakovo, and Glazkovo culture groups (Table 1.1). The following is a brief description of mortuary practices associated with each of the three culture groups (Derevyanko 1994, Haüsler 1968, Link 1998, Michael 1958, Tolstoy 1958, Weber 1994, 1995, Weber et al. 2002). Kitoi mortuary activity includes burials that were generally single or multiple, extended, and often missing the skull. Burial orientation varied with some individuals lying northeast and others southwest. The deceased were covered liberally with red ochre and there was an absence of stone slabs or cobbles in grave construction, which were common among both the Serovo/Isakovo and Glazkovo culture groups.

Table 1.1 Culture groups of the Lake Baikal region, Siberia (Weber et al. 2002).

Culture	Cal. Age (BC)*	Period
Early Kitoi culture	ca. 6800–5800	Late Mesolithic
Late Kitoi culture	ca. 5800–4900	Early Neolithic
Hiatus	ca. 4900–4200	Middle Neolithic
Serovo culture	ca. 4200–3400/3000	Late Neolithic
Glazkovo culture	ca. 3400/3000–1000	Bronze Age

*All ages provided in this dissertation are presented in calibrated years BC, with the exception of actual radiocarbon dates, which are presented in radiocarbon years BP ± 1 standard error.

Serovo/Isakovo individuals were placed in stone-filled pits usually as single, extended burials. Graves are described as relatively simple and uniform in position, orientation, and grave goods (Weber 1994:3) both within each cemetery and between Serovo/Isakovo cemeteries. Red ochre was rare and occasionally partial, or total cremation was practiced. Cremation is defined here as the reduction of remains by intense heat.

Finally, Glazkovo mortuary activity is characterized by graves covered and filled with stone. Burials were usually single though there were multiple burials as well. The position of Glazkovo individuals was extended or slightly flexed, supine, with arms lying at the sides or resting on the abdomen. Burial orientation was uniform with burials generally lying west to east, while Serovo burials laid south to north. Burials may have been cremated or partially cremated. Again, red ochre was rare.

The archaeological data suggest that the Kitoi culture group disappeared from the region around 4900 BC, and the region was not repopulated again until the introduction

of the Serovo/Isakovo and Glazkovo approximately 700 years later (Weber 1995, Weber et al. 2002). The reasons for this discontinuity have yet to be determined.

Paleopathological research reveals that conflict, malnutrition, or disease were probably not the cause of the Kitoi disappearance (Link 1998). Comparison of skeletal trauma, age-related degeneration, occupational stress, dental pathology, and enamel defects between pre- and post-hiatus groups failed to demonstrate that any of these factors were severe enough to eradicate an entire pre-hiatus population.

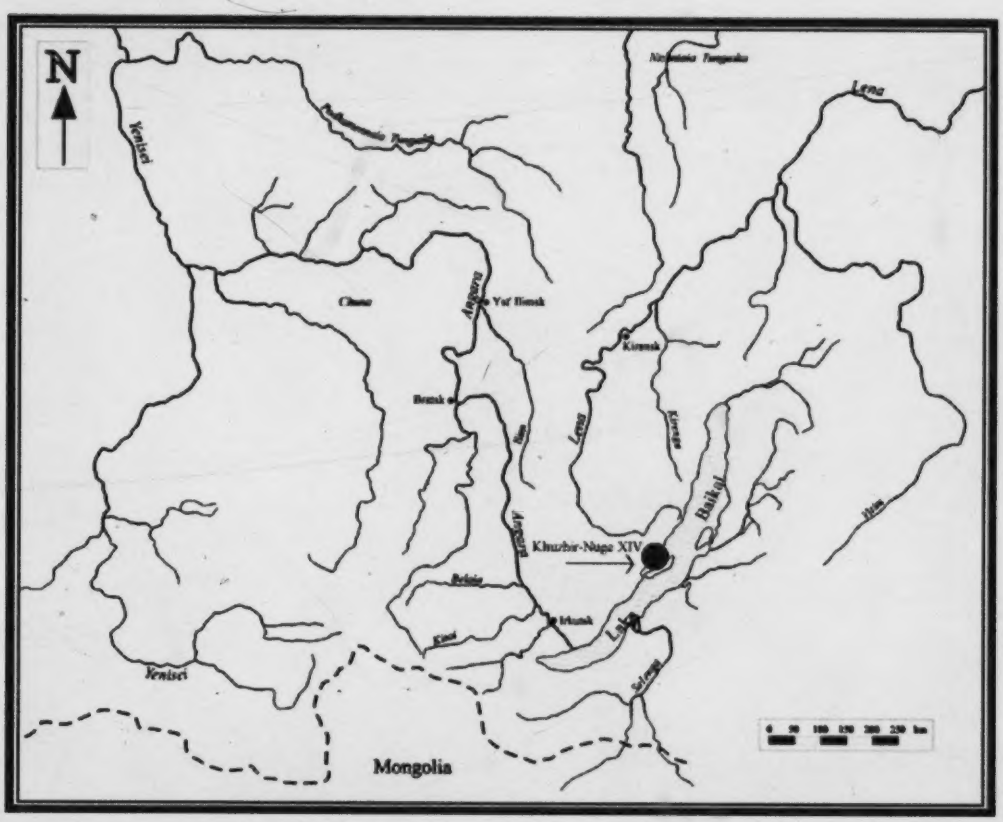
Various types of analysis are currently underway in order to further investigate this question through examination of biological and cultural characteristics of the human groups on both sides of this temporal hiatus. This long-term research project is managed by Dr. Andrzej Weber of the Department of Anthropology at the University of Alberta, Canada in collaboration with the Department of Archaeology and Ethnography at Irkutsk State University, Russia (http://baikal.arts.ualberta.ca). The primary source of data for the project is provided by the excavation and analysis of human remains from prehistoric mortuary contexts, namely the KN XIV cemetery.

Khuzhir-Nuge XIV represents the latter part of the post-hiatus culture groups. The site was initially investigated in 1993 by Olga I. Goriunova, Irkutsk State University, who exposed five graves at that time. In 1997, a group of Canadian researchers under the direction of A. Weber joined Goriunova's Russian team and these two teams conducted investigations during five consecutive field seasons (1997–2001). Seventy-four graves

with 84 burials have been excavated at KN XIV, not including the five graves of which data are unavailable that were excavated previously by Goriunova.

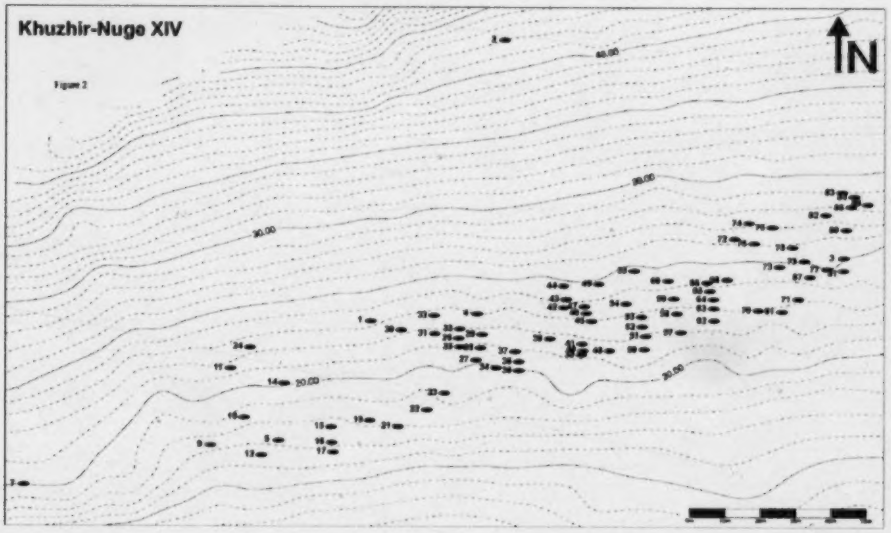
The location of KN XIV within the Lake Baikal region (Figure 1.1) is distinctive as most of the previously excavated large cemeteries are located in the Angara River Valley. In addition, KN XIV is the largest Bronze Age cemetery excavated on the shoreline of Lake Baikal.

Figure 1.1 Map of Lake Baikal region.



The site lies on a southeastern slope rising from the Little Sea region of Lake Baikal. The graves were located within an area that is approximately 300 m east to west and between two bedrock outcroppings lying 150 m apart north to south. Many of the graves were situated in rows running north to south with the longitudinal axis of the burial situated east to west. However, some graves lay in a less-orderly fashion (Figure 1.2).

Figure 1.2 Khuzhir-Nuge XIV site plan.



The graves were distinguished within the site as clusters of flat stones. The cluster was usually oval in shape, ranging from 2–3 m by 3–5 m, and may have been flat or slightly mounded. The stones once formed a cairn over the body, usually with a deliberately excavated pit underneath. The depth of each grave was approximately 25 to 85 cm below surface. Grave pits were often filled or lined vertically with stones.

Grave goods included stone tools such as chert and quartzite blades and inserts and bone tools such as fishhooks, harpoons, blades, points, pressure flakers, and spoons. Bronze/copper artifacts include awls, knives, rings, bracelets, and a needle. Cylindrical talc beads, green and white nephrite ornaments, bone and tooth pendants, river worn pebbles, and pottery were also present in the grave as were pieces of charcoal, and fragments of wood (thought to be birch bark). In a few instances there were red-stained bones, which may provide evidence for the mortuary use of red ochre. Most of these artifacts were located at the burial level.

The burials were usually situated with the head pointing west in an extended, supine position, though there were exceptions with some individuals flexed and lying on their sides. Arms were extended at the side of the body, resting on or tucked beneath the pelvis, or bent resting on the abdomen. Burials were usually single, although there were double (n=7) and triple (n=2) burials. Most burials were primary interments, but as many as five burials may have been secondary.

1.2.2 PREVIOUS TAPHONOMIC RESEARCH AT KHUZHIR-NUGE XIV

Previous taphonomic research at KN XIV, which attempted to identify the factors responsible for the inconsistent condition of human remains, suggested that future research should focus on explanation of cultural, particularly mortuary practices, likely variations in grave attributes (Lieverse 1999:127).

Lieverse examined three aspects of general skeletal condition, notably completeness, fragmentation, and articulation as dependent variables for each skeletal element. For simplicity, certain skeletal elements were grouped together. These included the left and right ribs (12 elements each), cervical vertebrae (7 elements), thoracic vertebrae (12 elements), lumbar vertebrae (5 elements), the left and right carpals (8 elements each), the left and right metacarpals (5 elements each), the left and right manual proximal phalanges (5 elements each), the left and right manual intermediate phalanges (4 elements each), the left and right manual distal phalanges (5 elements each), the left and right tarsals, excluding the calcanei and tali, which were represented independently (5 elements each), the left and right metatarsals (5 elements each), the left and right pedal proximal phalanges (5 elements each), the left and right pedal intermediate phalanges (4 elements each), and the left and right pedal distal phalanges (5 elements each; Lieverse 1999, 2000).

Completeness was scored by estimating the percentage of each skeletal element or elements that were present. For example, if the left metacarpals were represented by two elements, both 100% complete, the left metacarpal group completeness would be expressed as 200% (the total element completeness) divided by five (the number of left metacarpals or 'fragments' comprising the group), thus yielding a completeness of 40%. If an element (or group of elements) was absent it was expressed as zero (Lieverse 1999:76).

Fragmentation was expressed as a ratio between the completeness and number of fragments recovered. It was calculated by dividing the completeness percentage by the number of fragments for each element or element group and then multiplying that number by the number of elements within the group. For example, a 50% complete humerus consisting of two fragments would have a fragmentation ratio of 25. If the humerus was 50% complete but consisting of 50 fragments it would have a fragmentation of one (Lieverse 1999:77).

Articulation was expressed as a dichotomous nominal variable, either articulated or disarticulated, based on both the extent of articulation or disarticulation and the size of the skeletal element. For example, assuming original orientation, a phalanx found 10 cm from its original position would have been deemed disarticulated, while a femur would not have. However, if a femur were oriented with its proximal end distal and distal end proximal, it would have been disarticulated even if it were located more or less in its original position (Lieverse 1999:77).

These dependent variables were then analyzed within the context of 17 independent variables. Lieverse (1999) refers to factors stemming from individual characteristics and attributes of the skeletal remains themselves as 'intrinsic' while environmental and cultural taphonomic agents are considered 'extrinsic'. The independent variables included four intrinsic and thirteen extrinsic taphonomic factors. The intrinsic factors included element type, element side, sex, and age at death of the individual, while the extrinsic factors included burial depth, element charring, presence of birch bark, body

position, burial type, distance between the burial and underlying bedrock, burial disturbance, burial integrity, number of artifact types associated with the burial, total number of small (<15 cm), medium (15–30 cm), and large paving stones (>30 cm) per square meter of the grave pit, and grave pit area.

One-way analysis of variance (ANOVA) was conducted to establish the relation between the dependent variables of completeness and fragmentation by each independent variable, while binary logistic regression was conducted to determine the relation with the nominal dependent variable. In addition, crosstabs analysis was utilized to ascertain associations among independent variables themselves. Taken together, the independent variables accounted for 58% of variability in completeness, 77% of variability in fragmentation, and 85% of variability in articulation. While the remaining variability in fragmentation (23%) and articulation (15%) is relatively slight, the variability in completeness (42%) still requires explanation. It is likely that the inconsistency in general skeletal condition is attributable to cultural factors, which have yet to be identified (Lieverse 1999:127). Identifying these cultural factors is one of the goals of this project.

1.2.3 TAPHONOMY

When the term 'taphonomy' was first introduced, it was defined as the study of the transition of animal remains from the biosphere to the lithosphere (Efremov 1940). Though the term was new, the science of taphonomy was not. Research of this nature

had already been developed in 1928 by Richter under palaeontology as actuopalaeontology (Solomon 1990). Actuopalaeontology sought to understand trace fossils (ichnology), the destruction of animals and embedding of their remains, and biofacies (Efremov 1940). Since then, taphonomy has expanded from its palaeontological and palaeoecological roots to join other sciences including palaeoanthropology, archaeology, and forensic anthropology and has been further defined to meet the needs of these disciplines (Behrensmeyer 1984, Bonnichsen 1989, Haglund and Sorg 1997 and 2002, Olson 1980, Solomon 1990, Walters 1990). Reviews of taphonomic research have been presented in Cadee (1991) and Gifford (1981). For the purposes of this study, taphonomy is defined using Gifford's definition (1981) as the area of palaeontological research that defines, describes, and systematizes the nature and effects of processes that act on organic remains after death. I would also add 'explanation' of these processes as one of the goals of taphonomy.

Accepting Gifford's definition, human taphonomy can then be defined as the study of the nature and effects of processes acting strictly on human remains after death. Nawrocki (1995) divided these taphonomic processes into three general categories: individual, environmental, and cultural. It should be noted that these three taphonomic categories are not mutually exclusive (Nawrocki 1995). For example, certain variables can be classified as both environmental and cultural.

According to Nawrocki's approach, individual taphonomic factors are associated with the remains themselves and include characteristics such as bone shape, size, and density,

the amount of soft tissue, and disease and nutrition (Evans 1963, Galloway et al. 1997, Gill-King 1997, Ortner and Putschar 1995).

The majority of taphonomic research focuses on the category of environmental factors and includes data gathered in both archaeological and forensic contexts. Environmental factors comprise biotic and abiotic agents. Biotic agents are the living organisms that act on human remains. These agents include plants, microscopic organisms such as fungi and bacteria, and a variety of animals from small to large, such as insects, rodents, carnivores, and even bone-chewing herbivores (Bass 1997, Galloway 1997, Garland et al. 1988, Gifford 1981, Hackett 1981, Haglund 1992 and 1997, Haglund et al. 1988 and 1989, Hall 1997, Haskell et al. 1997, Henderson 1987, Hill 1976, Janaway 1996, Lyman 1994, Merbs 1997, Micozzi 1991, Milner and Smith 1989, Murad 1997, Nawrocki 1995, Patel and Path 1994, Payne and King 1968, Rathburn and Rathburn 1997, Rodriguez and Bass 1985, Schultz 1997, Sutcliffe 1971,Willey and Snyder 1989).

Abiotic agents are non-living environmental factors such as matrix type, pH, ambient temperature, humidity, precipitation, exposure to salt and fresh water, and freezing and thawing cycles (Boyle et al. 1997, Brooks and Brooks 1997, Cotton et al. 1987, Galloway et al. 1989, Gill-King 1997, Gordon and Buikstra 1981, Haglund 1993, Mann et al. 1990, Mant and Furbank 1957, Micozzi 1986 and 1997, Murray and Tedrow 1992, Nawrocki et al. 1997, O'Brien 1997, Rodriguez and Bass 1985, Sorg et al. 1997, White and Hannus 1983).

Although data on environmental and individual taphonomic factors were collected at KN XIV, they were not examined independently. Ideally, examination of site taphonomy includes all three categories of processes: individual, environmental, and cultural. However, it is beyond the scope of a single dissertation to do so. Lieverse's study emphasized the significance of cultural practices as taphonomic factors affecting skeletal condition and stressed the importance of analyzing these factors in more detail. Therefore, this investigation focuses on the cultural processes observed at KN XIV.

Nawrocki (1995) defines cultural taphonomic factors as a special subset of variables characterizing human mortuary activity, for example embalming and autopsy procedures, as well as many other death-related activities. In addition, human activities taking place well after death of the individual are included, for example factors associated with excavation and curation of human remains.

> The question may arise as to why one would include cultural behaviors, such as burial methods and excavation, as taphonomic variables. Simply put humans are a major source of modification and alteration that can affect the distribution and preservation of human remains. It is a useful heuristic device that helps the archaeologist, working from the perspective of the skeleton, to perceive the sum total of factors that are likely to influence the survival and morphology of bone over time. However, the unique and complex nature of human modification warrants the inclusion of a third, separate category rather than simply lumping human effects into environmental effects (Nawrocki 1995:55).

Existing research in which cultural agents are treated as taphonomic factors is limited. In many cases, relevant factors have been lumped into the category of mortuary ritual, but not analyzed specifically with regard to their role as taphonomic processes despite their established significance. Human agents are themselves among the most potent of the range of taphonomic processes (Holland et al. 1997) as they may be active participants in the alteration of remains at each stage after death: preparation, disposal, and recovery.

The most marked cultural taphonomic factor occurring at KN XIV was the use of fire, which resulted in charring of human remains in the grave. At least 54 graves at KN XIV revealed evidence of fire either as charred sediment, small fragments of charcoal within the grave, or discolored and/or fractured bone resulting from exposure to fire. Twenty of the 54 burials revealed bones altered by fire, whereas the remaining graves were those with charred sediment or charcoal within the grave, but the bone itself was not affected by fire.

Although the use of fire in mortuary activity is a well-known occurrence in the archaeological record, it has not been adequately examined as a taphonomic factor. Study of cremated bone has resulted in the application of a wide range of research techniques in various experiments, usually producing incomparable results (Mayne-Correia 1997:275). Mayne-Correia (1997) divided the previous research into three general categories. These include the study of visual characteristics, histological characteristics, and analysis of demographic factors. Histological analysis identifies microscopic changes of bone in the process of cremation and corresponding

temperatures, but provides little information regarding overall cremation technology and larger-scale taphonomic influences associated with fire-affected bone. Visual characteristics include macroscopic traits such as color, fracture and deformation, and shrinkage (Mayne-Correia 1997). Chapter 2 in this dissertation examines demography and visual characteristics. Additionally, technologies used in cremating remains are also examined in Chapter 2. Previous laboratory tests in which bone was burnt at increasingly high temperatures in ovens under controlled conditions have little relevance in understanding how ancient bone was burned at open-air sites such as KN XIV. Few studies have documented how bones were burnt in the past, but certainly technology plays an important role in recreating past mortuary activity and interpreting archaeological remains.

The second cultural factor is the application of red ochre. Red ochre, a generic term designating red or reddish mineral pigment, has been found in trace amounts in at least four Glazkovo graves at KN XIV. The origin of the red ochre as natural or cultural at this site is not known. Ochre existed as small patches of stained sediment within or near the burial level, or possible staining of the skeletal elements themselves. Red ochre was not considered in Lieverse's research (1999, 2000), probably under the assumption that it plays little to no role in the completeness, fragmentation, and articulation of the skeleton. Despite the fact that ochre was not used extensively at KN XIV, there had been considerable application of ochre among individuals of the Kitoi culture group. Archaeological studies concerning red ochre tend to concentrate on its possible symbolic

role. Chapter 3 is a new treatment of red ochre paying particular attention to its impact on skeletal condition.

Taphonomic factors associated with body disposal reveal a wide range of variation both spatially and temporally. Burial locations may include cemeteries, earthworks, caves or rock-shelters, association with buildings, collective graves, battlefields, or incidental interments such as in a hearth or refuse pit (Lovell 1999). The manner in which bodies are placed in their final resting place is similarly diverse. For example, bodies may be placed in pits, tombs, or on the surface. Burials can be primary or secondary, laid in various positions with or without associated features and artifacts. All of these human choices of disposal contribute to the future state of the remains.

Six factors associated with grave architecture have already been examined at KN XIV by Lieverse (1999, 2000): burial depth; distance between the burial and the underlying bedrock; number of small, medium, and large paving stones; and grave pit area. Chapter 4 examines the taphonomic impact of grave type, pit dimensions, and the number of paving stones.

Taphonomic factors related to body removal include all human activities associated with exhumation of skeletal elements and may include excavation, curation, transportation, and various types of analyses of the remains. All of these activities can have a profound impact on the resulting condition of skeletal remains. Because it is beyond the scope of this project to assess the impact of systematic archaeological and

laboratory techniques on human remains, grave disturbance primarily in the form of looting, is the focus of this section.

At least 57 of the 74 graves showed evidence of disturbance at KN XIV. Research regarding the taphonomic impact of burial disturbance by humans, which may include but is not limited to looting (intentional taking objects from the grave), is scarce. Burial disturbance at KN XIV was examined previously as an independent variable but only in very general terms (Lieverse 1999). It can be very difficult to distinguish between graves that have been disturbed naturally versus those that have been disturbed through human activity, as well as determining those graves that have been looted versus those that were disturbed for other purposes (e.g. mortuary ritual). Chapter 5 focuses on the types of human disturbance at KN XIV and the taphonomic influence of disturbance on skeletal condition.

Finally, data gathered from each of the above studies have resulted in the concluding study (Chapter 6), which examines rates of decomposition in a mortuary context in the Edmonton, Alberta region. Chapter 6 presents the combined effects of certain environmental and cultural taphonomic agents and provides data for a specific burial technique, stone covered, which may provide for estimation of time of death in the this region.

1.3 RESEARCH OBJECTIVES AND DESIGN

The primary objective of this research is to identify, describe, and understand the role of the cultural taphonomic factors and their effects on human remains at KN XIV. Secondarily, the goal is to develop an experimental strategy to further examine these factors. In her research, Lieverse demonstrated that certain taphonomic factors significantly contribute to general skeletal condition (1999, 2000). However, there were also cultural processes at work at KN XIV, including those mentioned above, that need to be defined and examined in more detail. In particular, the mortuary use of fire, potential use of red ochre, grave architecture, and grave disturbance are investigated in this dissertation. In addition, unrelated to the taphonomic processes at KN XIV, but resulting from the experimental component of this project, is a report on decomposition stages as they relate to certain aspects of taphonomy, namely burial depth, size of the individual, ambient temperature and humidity, and clothing.

Experimental archaeology is an approach that attempts to apply methods of controlled experiments for data collection, description, interpretation, and explanation to archaeological research problems (Ingersoll et al. 1977). Generally speaking, an experiment is the test of a hypothesis in which at least one variable is controlled. This dissertation tested the general hypothesis that specific cultural processes affect resulting skeletal condition often in a predictable manner.

Experimental research was conducted at a replicate cemetery site at the University of Alberta Ellerslie Biological Field Station in Edmonton, Alberta, Canada. The site

provided a large, natural setting with very minimal transient human impact. Domestic pigs (*Sus scrofa*) were utilized as human analogues in the experiments. Animals were not killed specifically for this project. An Edmonton area animal processing plant supplied pigs that had died prior to their arrival. The use of domestic pigs as models for humans is well established (Anderson and Cervenka 2002, Anderson and VanLaerhoven 1996 and 1999, Dillon 1997, France et al. 1992 and 1997, Haskell et al. 1997, Hewadikaram and Goff 1991, Janaway 1996, Komar 1999, Morton and Lord 2002, Payne and King 1968, Schoenly et al. 1991, Shean et al. 1993, Vance et al. 1995). Pigs are considered to be the best available human analogue due to their similar thoracic cavity size (Schoenly et al. 1991), relative lack of body hair, and omnivorous diet, thus a similar digestive fauna (Anderson and VanLaerhoven 1996). Availability of pig carcasses was also an important factor facilitating the experimental approach.

This dissertation research is the first large-scale taphonomic examination that focuses on cultural factors. Khuzhir-Nuge XIV provides the model for defining and examining these factors. It should be mentioned that the intention of this study is not to create an exact replication of the mortuary activity observed at KN XIV. There are distinct differences as well as some similarities between the environments of KN XIV and the Ellerslie Biological Field Station. While a complete understanding of site taphonomy requires examination of all factors, environmental and individual as well as cultural, it is beyond the scope of this project to examine them all. Instead, this study is meant to introduce the important role human activity plays on skeletal condition, which has long

been overlooked in taphonomic studies. Second, the methodology is unique as it applies a largely experimental approach to understanding the role of cultural taphonomic factors in an archaeological case study. Finally, understanding cultural taphonomy at KN XIV also expands the context data surrounding Glazkovo mortuary behavior, which may be important for other studies within the Baikal Archaeology Project.

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2. THE MORTUARY USE OF FIRE AT KHUZHIR-NUGE XIV [1]

2.1 INTRODUCTION

Although humans may have been using fire for over 1.4 million years (Gowlett et al. 1981), the earliest reported evidence for the mortuary use of fire is an approximately 40,000 year-old cremation at Lake Mungo, Australia (Bowler et al. 2003). Mungo Lady, as she is known to local aborigines, includes incomplete, fragmented, and charred cranial and post-cranial remains. Later, during the Neolithic, cremation occurred simultaneously with inhumation in the Near East and Eastern Europe (Childe 1945, Irion 1968).

Interpreting the technology associated with these early cremations as well as the intentions for choosing cremation is difficult due to both the condition of the remains and the fact that there exists no written or oral record. Irion (1968) suggests the technology of fires was relatively standardized since only open fires were available and thus complete incineration is rare. Nevertheless, throughout history cremations have been reported as both complete, reducing the body to ashes and bone fragments, and partial, reducing only a portion of the remains to ashes and bone fragments, or sometimes there was only minimal charring of bone (Barber 1990). With regard to why cremation may have been used, Irion states (1968) that fires may have been a means for drying and preserving the body, as part of preparation for a funeral feast or sacrificial ritual, or purification ceremony.

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Throughout the Bronze Age, cremation was more common in parts of northern Europe and the British Isles and in many regions the cremated remains were often interred inside of urns (Spence 1967). Cremation also played a role in the burial customs of many different groups in North America since the Late Archaic period (Binford 1963) and in early civilizations of the Old World.

Irion (1968) reports that two Babylonian crematoriums have been excavated near Lagash in which the bodies were wrapped in combustible material and encased in clay. They were then placed on a brick platform and enclosed in a funeral pyre. Their remains were collected and placed in jars with grave goods, indicating a belief in the continuing spirit of the deceased (Irion 1968). Cremation in Greece is depicted in Homeric literature as a form of disposal for Greek soldiers. The ashes of the soldiers were taken to their homeland, entombed, and most often buried. Periodically, Greeks and Romans cremated bodies near their intended grave (Barber 1990). In Greece, as well as in Rome, the practice was relatively elaborate and expensive and therefore, not extended to the poorer classes. Cremation was also denied to Greeks who committed suicide, infants whose teeth had not yet erupted, and persons struck by lightening as they were thought to be in disfavor of the gods. According to Irion, (1968), in Greece, fire symbolized the purification and release of the soul and unification of the body with its original elements. In Rome, poorer people may have been buried with much smaller pyres or communal pyres without expensive pitch or oil (Irion 1968). To call a man's ancestor "half-burned" was a well-understood insult in reference to an insufficient funeral pyre (Irion 1968:8).

Many Asian cultures also practiced and continue to practice cremation including Tibetans, Japanese Shinto and Zen and Tendai Buddhists, and Thai. Cremation began in India as early as the second millennium BC where fire purified the spirit in preparation for its reincarnation (Irion 1968). In India today, pyres are constructed using wood, fats, and oils but there is not always sufficient fuel for the poorer people resulting in incomplete cremations. In these cases, bodies are placed in urns or disposed of in the Ganges River (Barber 1990, Irion 1968).

In the Baikal region of Siberia, both partial and complete cremations occured among Late Neolithic/Early Bronze Age Serovo and Glazkovo groups (Haüsler 1968, Tolstoy 1958). Haüsler (1968) also reports hearths found near or above burials of the Late Mesolithic/Early Neolithic Kitoi group. Bazaliiskii (2003) reports ashpits in the fill of all burial pits at the Late Neolithic Ust-Ida I cemetery. Although the use of fire in mortuary activity is well documented in the archaeological record of the Baikal region, it has not been adequately examined as a taphonomic factor.

Certainly one of the key cultural taphonomic factors occurring at Khuzhir-Nuge XIV (KN XIV), a Serovo/Glazkovo cemetery on the shores of the Little Sea region of Lake Baikal, is the application of fire to human remains in the grave. At least 54 of the 74 graves revealed use of fire, either indirectly, as charred sediment or small fragments of charcoal within the grave, or directly, as burials with discolored and sometimes fragmented bone (Figure 2.1). Of the 84 burials, i.e., individuals, 20 exhibited a direct association with the presence of charred bone such as that observed in Burial No. 66, in

which at least the skull, mandible, teeth, vertebrae, scapulae, and left ribs are all charred (Figure 2.2, note that the flags indicate the location of charcoal fragments). In a few cases, the burials represent nearly complete cremations, as seen in Burial No. 54 (Figure 2.3).

Figure 2.1 Charred and fragmented remains of Burials No. 62.1 and 62.2, Khuzhir-Nuge XIV (photo A. Weber)).

Figure 2.2 Charring at superior end Burial No. 66, Khuzhir-Nuge XIV (Photo A. Weber).

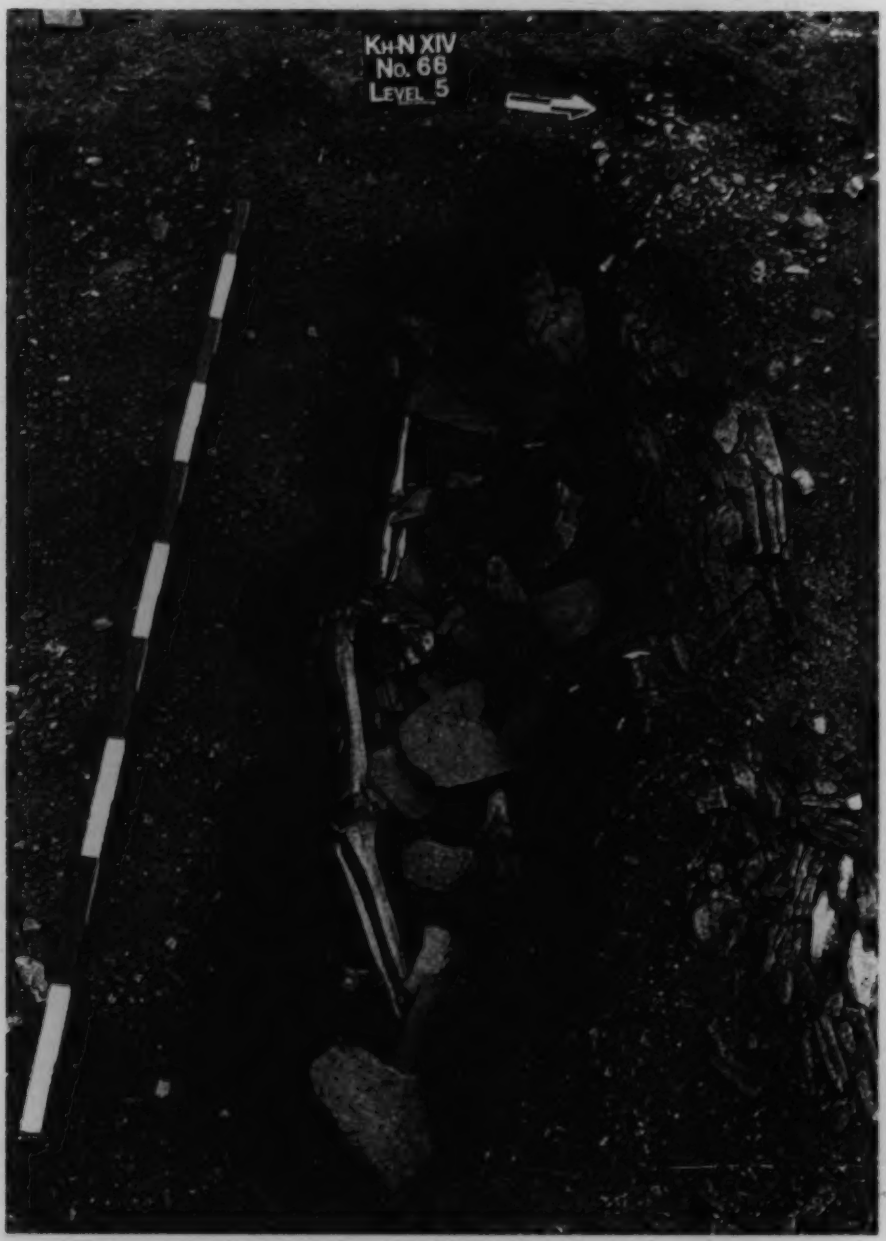


Figure 2.3 Cremated remains of Burial No. 54, Khuzhir-Nuge XIV (Photo A. Weber).

Previous research at KN XIV identified the impact of several taphonomic processes involved in the resulting skeletal condition (Lieverse 1999, 2000). While Lieverse's initial study (1999) did conclude that charring had a significant impact on skeletal condition there is still much to be learned regarding this taphonomic process such as the demographic profile associated with charred remains and the technology associated with the skeletal condition.

The first objective was to determine biological age, sex, and archaeological age for all the individuals affected by fire at KN XIV in order to ascertain if fire was selected exclusively for a specific group or period of time. The second objective was to examine skeletal condition characterized by color, completeness, articulation, and fragmentation as well as to analyze charcoal in the graves to see if the burials and their artifacts could contribute to the knowledge surrounding the technology used in constructing the fire, including the source of fuel, intensity of heat and duration of burning, and location of the fire in the grave. The third objective was to further examine these factors mentioned above through experiments in Edmonton, Alberta to test what was learned about technology at KN XIV and to learn more about effects of fire on burials.

2.2 METHODS

The study was conducted in two phases: phase one involved a direct examination of the 20 charred individuals from KN XIV, while phase two was an investigation of fire use through experiments with pig carcasses.

At KN XIV, demographic information was gathered using standard osteological procedures on remains that were sufficiently preserved (Lieverse, in press). Biological age was assigned as old adult (50+ years), middle adult (35–49 years), young adult (20–34 years), adult (20–50+ years) (Buikstra and Ubelaker 1994:9), or undetermined, unless age could be further defined by dental formation and eruption, or attrition, in which case specific age ranges were assigned (Ubelaker 1989). The subadult age ranges include 11.5–20, 7.5–11.5, 4–7.5, 2–4, and less than .5 years. The osteological sex was recorded as male, probable male, female, probable female, or undetermined. These determinations were based on a number of standard non-metric cranial and os coxae indicators, as outlined in Bass (1995), Bennett (1993), and Buikstra and Ubelaker (1994) and several metric traits as outlined in Bass (1995), Buikstra and Ubelaker (1994), and Montagu (1960).

Archaeological age was determined using accelerator mass spectrometry (AMS) at the Isotrace Laboratory at the University of Toronto, Ontario. AMS Radiocarbon age of 10 of the 20 charred individuals was examined to see if the mortuary use of fire was restricted to any period of time the cemetery was in use.

Visual characteristics, with regard to charred individuals, were examined during the 2001 field season. These include color and location of charring, completeness and degree or extent of burning, articulation, and fragmentation of each skeletal element or group of elements as in the case of hands, feet, ribs, vertebrae, the cranium, and the teeth.

Reduction in bone length and width, often referred to as shrinkage, is another characteristic of burned bones when exposed to temperatures above 700–800°C (Mayne-Correia 1997). Based on the condition and color of bones at KN XIV, fires likely did not reach such high temperatures; therefore, shrinkage is not analyzed here.

It is important to note, that currently there is no adequate standard for characterizing prehistoric bone that had once been subjected to fire. Baby's (1954) classification system of completely incinerated, incompletely incinerated, or non-incinerated or "normal" bone is too broad for the purpose of this study since all of the bone altered by fire at KN XIV would fall under the category of incompletely incinerated. Eckert's et al's (1988) terminology for contemporary cremated remains as either charred (survival of internal organs), partial (survival of soft tissue), incomplete (bone survival only), or complete (ash) cannot be applied effectively to remains in antiquity, where soft tissue that may have survived exposure to fire would not have survived over time. More resolution is needed in creating categories for the classification of skeletal remains subjected to fire. The term 'charring' was used to describe these remains in Lieverse's (1999) initial study and will continue to be used in this investigation. Charring denotes any skeletal element or group of elements with a color change indicative of exposure to fire, whether or not fire affected the entire element or just a small part of it.

Studies that have examined cremated bone have linked bone color to temperature and, to a lesser extent, the duration of exposure to heat (Dunlop 1978, Gejvall 1969, Lisowski 1968, Shipman et al. 1984). With minimal heat (as low as 200–300°C) bone appears

slightly scorched or blackened. Above 800°C bone becomes calcined, bluish-gray to white in color. In one study, de-fleshed animal bone that burned in an outdoor fire took less than 5 minutes to blacken (David 1990). Shipman et al. (1984) reported that de-fleshed animal bone that burned inside an oven for 4 hours fell into five distinct color stages depending on the temperature of the oven. At KN XIV color was recorded for each charred element (or group of elements) by comparison with a Munsell color chart (Munsell 1992).

Not surprisingly, Lieverse (1999, 2000) found that charred elements showed a significantly lower degree of completeness than uncharred elements. In the study presented here, completeness was scored for each element or group of elements as either present/charred, present/uncharred, or absent. Notes were made regarding the extent of charring for each element when possible but, due to the poor preservation and high amounts of fragmentation, the degree of burning was too difficult and required too much time to quantify. These data were then transferred into a spreadsheet in Excel and also illustrated in skeletal diagrams to provide a visual representation of exposure to fire for each individual (Appendix A).

Lieverse (1999, 2000) scored articulation as articulated or disarticulated for each element or element group and showed that uncharred elements had a greater probability to be articulated with each other than with charred elements. There was no further examination of articulation.

Post-mortem fracture patterns were difficult to assess in the charred elements, as many of the bones were fractured longitudinally, likely as a result of other taphonomic processes, whether or not they were charred. Lieverse (1999, 2000) scored fragmentation of each element as a ratio between completeness and the number of fragments recovered and found a higher degree of fragmentation among charred remains as compared to uncharred. Again, fragmentation was not further examined.

Charcoal samples were also collected at KN XIV during the 2001 field season. Unfortunately, none of the burials excavated during this field season were charred. The charcoal came from various levels, including the burial level, of graves in which human remains were seemingly unaffected by fire. The origin of the charcoal in these cases is unknown but identification may still provide useful information. For example, charcoal may be an indicator of the species present at the time of burial, which in turn may suggest the source of fuel used in construction of the fires. Ten charcoal samples from six different graves were identified by palaeoethnobotanist Dr. Lucinda McWeeney of Yale University.

The key to understanding archaeological mortuary behavior is to reconstruct the ritual context in which the burial data are created (Roksandic 2002). The second phase of this examination utilized these data obtained from KN XIV to test the potential technologies and observe the resulting skeletal condition. Experimental research was conducted at a replicate cemetery site at the University of Alberta Ellerslie Biological Field Station in Edmonton.

The area, a gently rolling morainal plain with fine-textured glaciolacustrine sediments, provided a large natural setting outside of the city. The site lays approximately 53°N latitude and 113°W longitude with an elevation of 686 meters above sea level. The average annual temperature range is approximately –14.1°C to 17.3°C, with mean monthly temperatures below freezing for 5 months of the year. Average annual precipitation is 450 mm (http://www.worldclimate.com).

Experimental graves (pits and burials) were constructed to conform to what is known of Glazkovo graves at KN XIV. Six grave pits were dug using a backhoe at a length of 214 cm, width of 68 cm, and depth of 40 cm (the mean dimensions of length, width, and depth of all grave pits at KN XIV). Pits were placed 3 m apart.

Domestic pigs (*Sus scrofa*) were used as human analogues in the experiments. The use of domestic pigs as models for humans in taphonomy, decomposition, and forensic entomology experiments is well established as an adequate comparative model (Anderson and Cervenka 2002, Anderson and VanLaerhoven 1996 and 1999, Dillon 1997, France et al. 1992 and 1997, Haskell et al. 1997, Hewadikaram and Goff 1991, Janaway 1996, Komar 1999, Morton and Lord 2002, Payne and King 1968, Schoenly et al. 1991, Shean et al. 1993, Vance et al. 1995). Six pigs weighing approximately 45–50 kg each were supplied by an Edmonton area animal processing plant and were received no later than 48 hours after death. Therefore, the pigs were still considered fresh at the time of the experiments, within the context of the mock burials.

On August 18, 2002 six pigs (Burials no. 15–20 of the total 22 experimental pig burials) were laid in the pits and a fire was constructed over the top of them (Figure 2.4). Burials were situated west to east with the head to the west, primarily in an extended supine position, though sometimes resting slightly on their side. Experiments were designed to test results of fires using different types and amounts of fuel, and allowing the fire to burn for various amounts of time starting from 15 minutes to more than 1 hour. Two sources of fuel were used. Wood from the pine family was selected on the basis of the charcoal analysis results and wood from the birch family was selected because of its association with charring in the KN XIV graves. The weight of fuel ranged from 5–11 kg depending on the intensity of each fire, a factor not only controlled by fuel but also the temperature of ignition of the fuel, oxygen supply, and general technical suitability of conditions such as the weather (McKinley 1989). These factors are not easily controlled in an outdoor environment. Interestingly, 15 minutes was not enough time for the fire to reach the bone and the time was subsequently extended. Two other variables tested were the effect of burning on a burial wrapped in birch bark and a burial with red ochre applied to the body. Both characteristics have been found frequently amongst Siberian burials.

Figure 2.4 Burning stage of experiment, Burial No. 24 wrapped in birch bark (Photo M. Weitzel).

After the fire burned out, a stone cairn was constructed over the burial. The cairn consisted of 20–30 large and heavy paving stones. The size of each stone was approximately 5 cm by 30–50 cm by 50–100 cm. At KN XIV, the average number of stones placed over graves was 229. However, the stones at KN XIV were of various sizes and weights, both small and large.

2.3 RESULTS

2.3.1 DEMOGRAPHIC VARIABLES

Based on the demographic information, approximately 70% (n=14) of charred individuals were adults over 20 years old, 15% (n=3) were 11.5–20 years old, 5% (n=1) were 7.5–11.5 years old, 5% (n=1) were 4–7.5 years old, and 5% (n=1) were

undetermined due to the absence of certain skeletal elements and poor skeletal condition (Figure 2.5 and 2.6). The data suggest that mortuary use of fire occurred more commonly in the context of adult burials. However, the total number of all KN XIV adults, both charred and uncharred, exceeds the number of individuals under the age of 20 by 28%. Fire was used in all age groups over age four.

Figure 2.5 Age ranges of charred and total individuals at Khuzhir-Nuge XIV by number of individuals.

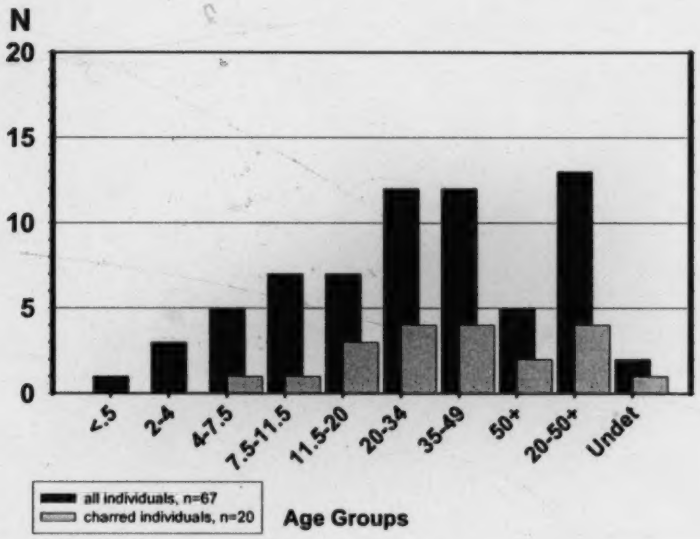
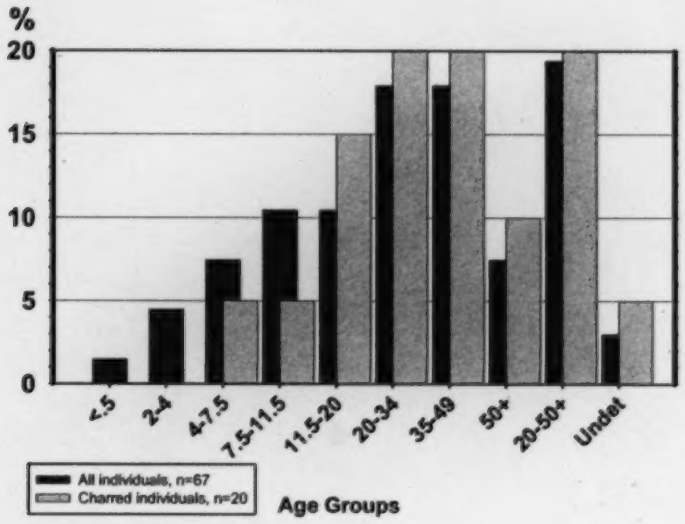


Figure 2.6 Age ranges of charred and total individuals at Khuzhir-Nuge XIV by percentage of individuals.



With regard to sex determinations, fire was used in both male and female burials. Approximately 45% (n=9 of total 28) of the charred individuals were male or possible male, 10% (n=2 of total 5) were female or possible female, and 45% (n=9 of total 54) were undetermined due to poor skeletal condition (Figure 2.7 and 2.8). Though there was a large percentage of males, versus females among charred individuals, there were many more males (n=28) than females (n=5) in total at KN XIV.

Figure 2.7 Sex of charred and all individuals at Khuzhir- Nuge XIV (PM = probable male, PF = probable female) by number of individuals.

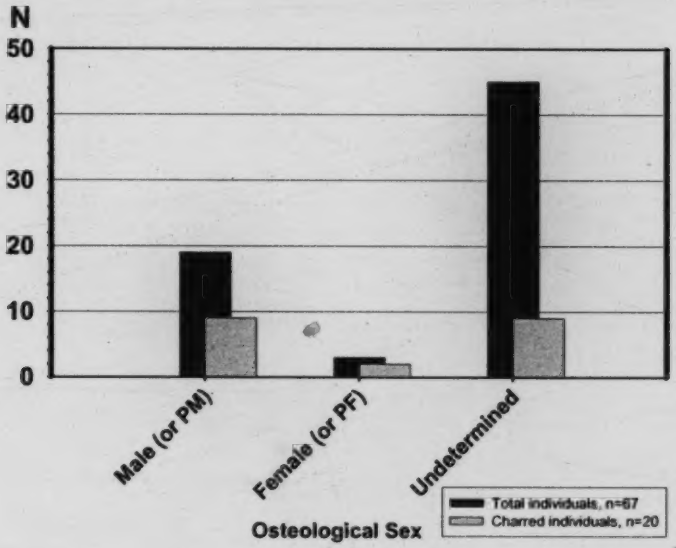
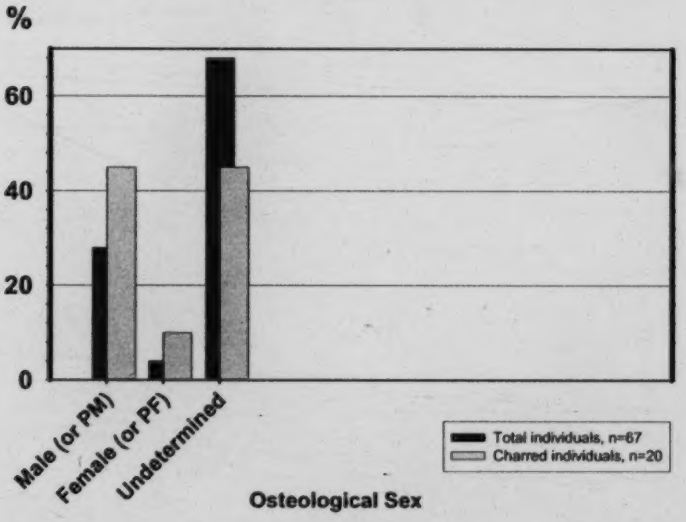


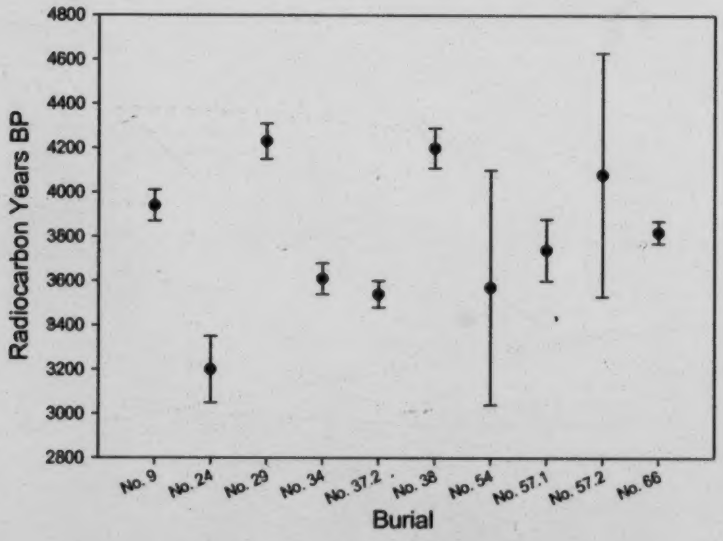
Figure 2.8 Sex of charred individuals and total individuals at Khuzhir- Nuge XIV (PM = probable male, PF = probable female) by percentage of individuals.



The AMS radiocarbon ages of charred individuals that have been dated (n=10) ranged from 3200 ±150 to 4630 ±110 BP. Individuals radiocarbon dated thus far fall within the age range for all Glazkovo individuals (3150 ±70 to 4820±90 BP), but not appearing to cluster within a particular period in time within that range (Figure 2.9). Lab numbers for the dates in Figure 2.9 are in order from left to right, TO6863, TO6868, TO8487, TO9380, TO9386, TO9387, TO9400, TO9402, TO9403, and TO9415.

Grave No.	Lab No.	C14 Age BP	s.e.
9	TO6863	3940	±70
24	TO6868	3200	±150
29	TO8487	4230	±80
34	TO9380	3610	±70
37.2	TO9386	3540	±60
38	TO9387	4200	±90
54	TO9400	3570	±530
57.1	TO9402	3740	±140
57.2	TO9403	4080	±550
66	TO9415	3820	±50

Figure 2.9 Radiocarbon age of charred individuals at Khuzhir-Nuge XIV.



2.3.2 VISUAL CHARACTERISTICS

2.3.2.1 COLOR

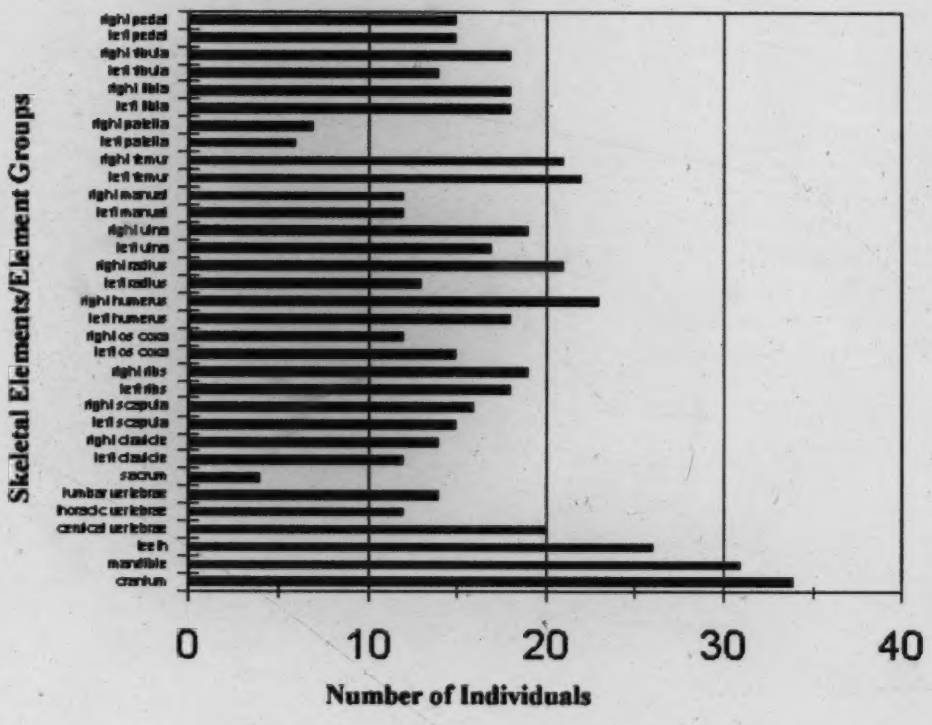
Colors of charred bone included black, very dark gray, dark reddish gray, dark gray, gray, and white. In most cases of charring, the color was black and penetrated the depth of the entire bone or bone fragment. Skeletal elements of seven individuals exhibited small spots of dark gray, gray, and white, all colors representing calcination. The colors suggest that temperatures were far below 800°C, though possibly reaching close to it in at least four cases (Nos. 9, 24, 28, and 29). It is also possible that the shades of gray and white were a result of burning for a much longer duration but still at temperatures much less than 800°C. The majority of colors suggest temperatures between 360 and 525°C based on data from Shipman et al. (1984). However, as mentioned previously, these temperatures were derived from experiments in which de-fleshed bone was burnt inside a kiln, i.e. in conditions obviously different from unenclosed outdoor wood fires ("campfires") over fleshed remains at KN XIV. According to Tylecote (1962), temperatures of approximately 400°C are normal for campfires and they rarely reach 700°C.

2.3.2.2 COMPLETENESS

Figure 2.10 shows completeness of combined charred/uncharred skeletal elements for 19 individuals exposed to fire at KN XIV. Note that Burial No. 82 is not included, as the charred long bones were unidentified. In descending order of frequency, the skeletal

elements most likely to be preserved, whether or not they were charred, were those of the skull including dentition, followed by the right humerus, left femur, right radius, and right femur, right ribs, right ulna, left ribs, left humerus, tibiae, right fibula, and left ulna. Charring was often localized on the superior aspect of the skeleton, particularly the skull, often including the dentition, proceeding to the humeri and vertebrae, ribs, and in some cases affecting the lower body. Charred bone resists decomposition far better under most weathering conditions than bone not exposed to fire (Merbs 1967:498). However, in the case of KN XIV individuals, more uncharred bones were preserved than were charred bones; this was true for every skeletal element or element group. There was better preservation of certain skeletal elements, such as vertebrae, among the charred remains. However, both anterior and posterior sides of the skeleton appeared to be affected equally. The right side of the individual was charred more often than the left, especially among skeletal elements of the upper body (including the clavicles, scapulae, ribs, humeri, radii, ulnae, and then the patellae and fibulae), as illustrated by Figure 2.10.

Figure 2.10 Distribution of charred (gray bars) and uncharred (black bars) skeletal elements for 19 individuals exposed to fire at Khuzhir-Nuge XIV.



2.3.2.3 ARTICULATION

Disarticulation patterns of charred burials at KN XIV were similar to that observed among uncharred burials with some exceptions. There were eight individuals of the 20 charred where disturbance of the fire or a portion of the fire could have resulted in their disarticulation (Burial Nos. 28, 41, 43, 52, 57.1, 57.2, 62.1, 62.2). While most of the charred burials remained in articulation overall, these eight individuals were moderately

to highly disarticulated. Burial Nos. 28, 41, and 43 consisted of bundles or clusters of bone in the grave. Bones of Burial No. 28 were transversely fractured and the underlying sediment included a thick layer of charcoal. The upper body of Burial No. 52 was disarticulated with the right radius and ulna lying west of their anatomical position and flipped resulting in the proximal end to the east and distal end to the west. The proximal ends of the bone shafts, lying directly on a stone slab, were separated vertically from their distal ends. The left humerus was approximately 25 cm west of its anatomical position and also flipped so that the proximal end was oriented northeast and distal end southwest. Grave No. 57 included two slightly commingled individuals. Cranial fragments of one were not completely distinguishable from the other and some of the leg bones of Burials No. 57.1 and 57.2 were not in anatomical position. Distal shafts of the left tibia and fibula of Burial No. 57.1 were crossed. Finally, Grave No. 62 also consisted of two commingled individuals, with more disarticulated skeletal elements than Grave No. 57 (Figure 2.1). Although other taphonomic agents could explain the condition of these burials, stirring the fire is one factor that should be considered.

2.3.2.4 FRAGMENTATION

Fragmentation was pervasive among all skeletal remains at KN XIV. Fractures may have resulted from a variety of taphonomic factors including exposure to fire. However, certain characteristics of fractures may help to distinguish between bones burned in the flesh or bones burned when dry. Dry bones that have been exposed to fire have been

reported to exhibit cracking, checking, or creating a patina-like surface, deep longitudinal fracturing or splintering, and a lesser occurrence of curved fractures and bone warping (Thurman and Willmore 1981). Individuals exposed to fire in the flesh are often incompletely incinerated. When calcined, in-flesh remains are blue or gray, have deep checking patterns, diagonal serrated transverse and curved fractures, irregular longitudinal splitting, and warping (Thurmann and Willmore 1981).

It should be mentioned that at KN XIV there was no indication that de-fleshing of bones occurred. In other words, cut-marks were absent. In fact, there were more characteristics in support of bones being burnt in the flesh, for example there was a lack of superficial checking patterns or a patina-like surface and at least four examples of transverse fracturing clearly associated with charred remains as opposed to those not affected by fire (Burials No. 9, 25, 28, and 29) (Baby 1954). Warping was observed among some of the long bones and crania at KN XIV. This type of warping, however, was probably the result of contact between the bones and heavy stones placed over them relatively soon after death rather than exposure to fire. In these cases, the entire bone is bent and often there is no other evidence of fire, i.e. they are not charred.

Unfortunately, many of the characteristics associated with fractures from fire cannot be examined in detail at KN XIV due to the overall poor preservation of bone, for example the degree of cranial delamination and the extent of fracturing at the joint surfaces. Furthermore, it is difficult from the state of the remains to determine if burning patterns conform to what would be expected for fleshed remains, that is, if heavily

muscled areas are less burned than areas with less muscle attachment. A much more detailed examination of the charred elements themselves would need to occur in order to observe these variations. Because most of the burning at KN XIV is characterized by charring rather than calcination, the colors and fractures of the bones overall appears relatively similar in both heavily-muscled (e.g. mandibular rami of the mandible) and less heavily-muscled areas (e.g. chin of the mandible).

The fact that most of the charred burials were in articulation at the time of excavation indicates that the use of fire may have followed soon after death (Ubelaker 1978) as bones without flesh are more likely to be moved through burning than those with flesh. Also, there are a few cases where the matrix is charred as well as skeletal material in the graves (e.g. in the grave of Burial No. 24). For all of these reasons mentioned above, it is the author's belief that most, if not all, of the burials at KN XIV were burned in the flesh but due to the overall skeletal condition this cannot be stated for certain.

2.3.3 CHARCOAL

The charcoal from KN XIV graves was identified as conifer of the pine family (Pinaceae), and more specifically as spruce (*Picea*) and larch (*Larix*) in some cases (Fernald 1950). Observing the identifications by level for each grave, it appears only one genus was represented per grave suggesting that if this was the source of fuel used for fires, only one type of fuel was used per grave (Table 2.1). Even though the charcoal comes from graves with uncharred bone, it is possible that the wood represented in these

graves was the same as that used for fuel in graves with charring. However, it must be pointed out that the charcoal in these particular graves may have resulted from other factors such as accidental intrusions by wind and rodents or fires built near the graves by prehistoric visitors.

Table 2.1 Khuzhir-Nuge XIV charcoal analysis.

Grave No.	Excavation Level	Identification	Amount
82	3	Pinaceae	0.3 g
83	5	*Larix* (larch)	0.2 g
84	1	*Larix* (larch)	60.2 g
84	4	Pinaceae	2–3 g
84	5	*Larix* (larch)	4.3 g
85	2	Pinaceae	1.6 g
85	5	Conifer	0.1 g
86	2	*Picea* (spruce)	14.3 g
86	3	*Picea* (spruce)	0.7 g
87	2	Pinaceae (possible spruce)	0.8 g

As the amount of heat varies with different types of wood, the wood used may be an important factor. Hardwoods, or those from broad-leaf trees such as oak, maple, and poplar, tend to burn slower and longer than softwoods, or conifers, such as pine, spruce, fir, and redwood. Holck (1986) reports that birch (*Betulla verruccosa*) produces 4.506 kcal/kg of heat by combustion, while spruce (*Picea* abies) is close to birch at 4.496 kcal/kg. Data for larch are not provided. Fragments of birch bark were found in 13 of the 15 grave pits with charred skeletal elements. Lieverse (1999, 2000) found that bone charring and the presence of birch bark were significantly associated.

The observations above have shed some light on the relationship between charred skeletal remains and demographic factors at KN XIV. Color, completeness and degree of charring, articulation, and fragmentation of skeletal elements, as well as charcoal analysis have provided clues to explain some possibilities regarding the technology used in the construction and maintenance of the fire. Experiments were then designed to further explore the technology and effects of fire on human remains.

2.3.4 EXPERIMENTS

Graves were opened on August 25–26, 2003, one year after the application of fire and subsequent burial. This period of time was chosen to allow the bodies to reach at least an advanced stage of decomposition in order to view changes affecting bone (Galloway et al. 1989). Skeletal and dental inventory forms for recording color, completeness, articulation, and fragmentation were used to determine the effects of fire on the bone. All burials were also photographed. The bodies were left in the grave pits and reburied for future observations.

Experiments are outlined in Table 2.2. The first experiment was conducted on Burial No. 15, which used 5 kg of pine and burned for 2 hours and 23 minutes. Examination of the burial a year later revealed two rodent nests among the skeletonized remains. The rodents were one of two types present at the Ellerslie site including house mouse (*Mus musculus*) and deer mouse (*Peromyscus maniculatus*) (Yvonne Kjorlien, personal communication). Though the pig was mainly skeletonized (Galloway et al. 1989),

remains displayed some mummification of tissue throughout. All bones appeared to be present and in articulation. As a result of sediment staining, the color of the bones was brown with the exception of the sternal ends of the lower left ribs, which were charred black from fire. These ribs were also fractured transversely at the sternal ends, a direct result of exposure to fire.

Table 2.2 Charring experiments.

Burial No.	Duration of Fire	Fuel of Fuel	Weight	Other	Results
15	2 h 23 min	Pine	5 kg	rodents	charring and fracture of left ribs
16	3 h 54 min	Birch	11 kg	n/a	charring and fracture of left ribs
17	2 h 39 min	Pine	7 kg	rodents	fracturing of right rib
18	2 h 32 min	Pine	7 kg	rodents	fracturing and disarticulation of right ribs
19	2 h 41 min	Pine	6 kg	birch bark	charring, fracturing, and disarticulation of ribs and sternum
20	3 h 17 min	Pine	11 kg	red ochre rodents	charring and fragmenting of left ribs

The second experiment, conducted on Burial No. 16, used 11 kg of birch and burned for 3 hours and 54 minutes. The remains were in an advanced stage of decomposition with mummified tissue over half of the body. Again, the only impact of fire was charring and transverse fracturing observed on the lower left ribs.

The third experiment, conducted on Burial No. 17, used 7 kg of pine and burned for 2 hours and 39 minutes. There did not appear to be any evidence of the use of fire on the skeletonized remains except one fractured right rib, but the rib was not charred. There

was some rodent gnawing at the proximal end of the right humerus and distal end of right femur.

The fourth experiment, conducted on Burial No. 18, used 7 kg of pine and burned for 2 hours and 32 minutes. There was some indication of charring in association with transverse fracturing on at least one right rib. Also, the ribs were slightly disarticulated. However, disarticulation could have been caused by rodents, as there was a nest in the thoracic region.

The fifth experiment, conducted on Burial No. 19, included a burial wrapped entirely in birch bark and burned with an additional 6 kg of pine for 2 hours and 41 minutes. This burial was more skeletonized than the others likely because the birch bark wrapping allowed the fire to spread across and consume more body tissue than in other burials. However, the charring of the bones was only slightly more pronounced in this burial than in the other experiments. Charring was present on the sternal ends of mid to lower left and right ribs and transverse fracturing was present on three right ribs and the body of the sternum. A few ribs were also disarticulated.

Finally, the sixth experiment, conducted on Burial No. 20, included a pig covered in red ochre, and burned with 11 kg of pine for 3 hours and 17 minutes. In an advanced stage of decomposition, the remains were completely stained in red ochre with some very small spots of charring on three, or possibly four left ribs. Rodent nests were found inside the rib cage and the lower abdominal area. Fragmentation of the first few left ribs

appeared to be caused by rodents as the ribs were gnawed at the sternal ends rather than fractured by fire.

The results from the six experiments were very similar to each other with almost every burial exhibiting charred and fractured ribs. This suggests that the disparity in the duration of burning and the type and amount of wood in these experiments made little difference in the effects of fire on bone. One exception to this is the burial wrapped in birch bark, which was in a more advanced stage of decomposition and revealed slightly more fragmentation, charring, and disarticulation of bones.

2.4 DISCUSSION

2.4.1 DEMOGRAPHIC VARIABLES

Analysis of demographic data from KN XIV provides little additional insight as to why some burials were exposed to fire and others were not, as charring was not strongly associated with either males or females or any biological or archaeological age. What has been learned is that the construction of fires over burials was intended for both males and females. Nine of the total 28 males were charred and two of the five females were charred. Fire also affected all age groups from at least age 4 to over age 50. The use of fire continued throughout almost the entire time the cemetery was in use. Demographic variables were not examined in the experimental phase of this study.

2.4.2 VISUAL CHARACTERISTICS

Analysis of charred bone at KN XIV and among the experiments has shown that fires will alter the color, completeness, articulation, and fragmentation of skeletal remains.

2.4.2.1 COLOR

The color of the bone at KN XIV indicates that fires were of a relatively low temperature or short duration. This was demonstrated by the general lack of calcined bone as verified by black rather than white and gray coloring among the skeletal remains. However, temperatures and durations of fires at KN XIV would have been much higher and longer, respectively, than those tested in the experiments. At KN XIV, the fires may not have been much larger in size than those constructed in the experiments, as the charring was usually localized rather than spread out on the skeleton (with the exception of Nos. 52, 54, 57.1, 57.2, 62.1, and 62.2) but it would have burned for much longer than 4 hours and would, therefore, have required more than 11 kg of fuel. Although other studies (David 1990, Shipman et al. 1984) have reported color changes after a few minutes to less than 4 hours, these cannot be applied to fleshed remains exposed to fire.

Burning showed a definite pattern with regard to the placement of the fire within the pit and in relation to the body. A principle of fire is that the location where material has burned the most is where it burned the longest and is, therefore, the point of origin of the fire (Richards 1977). In the experiments, the only part of the skeletal remains to show charring was on the bones directly under the center of the fire. Observing the location of

charring on KN XIV individuals, one can surmise that the fire was probably built on the west side of the pit over the superior end of the individual (skull and upper body region). Individuals constructing the fire most likely stood on the downhill side of the burial pit. The majority of the fuel probably lay closer to these individuals, thus affecting more of the right side than left.

2.4.2.2 COMPLETENESS

At KN XIV, completeness of skeletal elements was strongly influenced by the presence of fire, the occasional result being a complete absence of bones or parts of bones through cremation. However, among the burials that were charred, as opposed to cremated, at KN XIV it is difficult to say whether the absence of bones was a result of exposure to fire or simply decomposition through time. Factors such as animal scavenging and grave looting may have also played a role in completeness. Skeletal elements at the superior end of the individual tended to preserve best in burials, whether or not those elements were charred. Though the experiments did not result in the complete absence of elements, they did demonstrate the loss of parts of certain elements and it likely would have been possible for larger parts or all of certain elements to disappear had the fires been hotter and burned for much longer durations.

2.4.2.3 ARTICULATION

Disarticulation can also be caused by many taphonomic factors, including cultural factors, for example the removal or displacement of skulls by humans (Srejovic 1969, Rozoy 1987) as well as environmental factors, such as animal scavenging (Haglund and Reay 1993). Disarticulation solely from exposure to fire would result from collapse of burning bone and, therefore, would not have a large impact on the overall position of remains. An exception would be if the fire were stirred or restoked. This is a possibility in eight of the charred burials at KN XIV. The displacement of some ribs in the experiments could have been a result of collapse caused by fire but the associated rodent activity in the pit must also be taken into consideration.

2.4.2.4 FRAGMENTATION

It is impossible to determine the exact cause of fragmentation of bone at KN XIV. It was most likely caused by a combination of factors such as exposure to fire, weight of the stone cairn, and natural decomposition through time. It does appear, inferring from the type of fragmentation observed, that bones were burned in the flesh at KN XIV. Again, despite the fracturing from fire exposure that did occur in the experiments (Figure 2.11), the duration of burning and amount of fuel used were much less than that which would cause the level of fracturing seen at KN XIV. It is difficult to assess how much longer fires would need to burn to produce the level of fragmentation observed at KN XIV because the only available comparative studies use de-fleshed bones. Cremation in

modern crematoria usually takes 1–2 hours at a minimum temperature of 500°C to complete, i.e. to reduce a body to 3000 g, an average weight from a modern adult cremation (McKinley 1989). Holck (1986) suggests that due to thermal loss to the surroundings in an open-air cremation, cremating a body could have taken several hours and possibly all day and night. McKinley (1989) reports 7–8 hours to complete a cremation on a pyre. Furthermore, if the fires were stirred or restoked during tending, there would probably be further fragmentation of the hot, brittle, heat-fractured bone. A similar effect would come from the weight of added wood or a collapsing pyre (McKinley 1989).

Figure 2.11 Charred and fractured bones from experiments (Photo M. Weitzel).

2.5 CONCLUSIONS

Visual characteristics of human remains recorded at KN XIV and in experiments suggest that the mortuary fires at KN XIV burned for very long periods of time, perhaps up to or even over 12 hours (Holck 1986) at temperatures between 360°C and 700°C in order to produce the resulting color, completeness, and fragmentation. The source of fuel was likely wood from the pine or birch family and the degree of burning suggest amounts much greater than 11 kg. Fires were most often constructed at the west end of the pit over the superior end of the fleshed remains. However, in a few cases fires covered the entire pit. Construction of the fire closer to the individual that built it on the downhill side of the burial likely caused the right side of the skeleton to be charred more than the left. Finally, in some cases, stirring or restoking the fire could explain disarticulation and fragmentation of charred remains at KN XIV. Many burials (Nos. 25, 28, 38, 43, 52, 54, 57.1, 57.2, 62.1, 62.2) are completely cremated or at least cremated at the superior end of the skeleton. In these cases, a pyre of very considerable magnitude would be needed, possibly augmented with stoking as the process continued (Wells 1960).

Based on information learned from this study, future experiments should be designed to consider the following: 1) longer durations of time in which the pig is exposed to fire, perhaps as long as 12 hours or more; 2) construction of the fire over the superior region of the body as opposed to thoracic region; 3) monitoring the temperature of the fire in relation to changes in skeletal condition; 4) stirring the fire and observing how this affects skeletal condition; 5) building graves on a slope similar to KN XIV; 6) burning bodies at

different ambient temperatures or different seasons of the year; and 7) burning bodies at different body temperatures, for example frozen or very cold.

Though many methods have been developed to assess the effect of heat on bone, little research has been initiated to examine all possible variables associated with ancient bone that has been burned, associated technologies, and how these affect bone. Laboratory tests in which bone is burnt to controlled, increasing temperatures in ovens have little relevance in reconstructing how ancient bone was burned at archaeological sites such as KN XIV. Few studies have documented exactly how bones were burnt in the past, but certainly this factor plays an important role in recreating past mortuary activity and interpretation of archaeological remains. In addition to the experiments, examination of the mortuary use of fire as a taphonomic factor at KN XIV has shown that fire can be a very important agent in the alteration of skeletal remains with regard to color, completeness, articulation, and fragmentation.

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3. TAPHONOMY AND THE MORTUARY USE OF RED OCHRE

3.1 INTRODUCTION

Red ochre is an iron oxide (Fe_2O_3) derived from hematites and other iron-rich rocks, which are relatively common in natural, geologic, and soil formations (Erlandson et al. 1999). According to Tankersley et al. (1995), red ochre is composed of 69.9% iron and 29.9% oxygen with trace amounts of other elements such as silicon, calcium, magnesium, and aluminum. Iron is the element most commonly oxidized in a soil or weathering environment, and the oxidation products give the altered material the characteristic yellowish-brown to red colors (Birkeland 1984:72). Red ochre occurs as sedimentary deposits, concentrated or enriched by meteoric water and hydrothermal solutions, or as an accessory mineral in igneous rocks, high temperature hydrothermal veins, and in contact with metamorphic deposits (Mason and Berry 1968:292).

Red ochre also has an extensive cultural history. The earliest evidence for the mortuary use of red ochre or the intentional application of ochre over human burials is during the Upper Paleolithic. This phenomenon occurred predominantly in Europe, and later in Asia, Africa, and North America (Marshack 1981, Roper 1991, Tankersley et al. 1995, Wreschner 1980 and 1981). During the Late Mesolithic to the Early Neolithic (approximately 6800 to 4900 BC) in the Lake Baikal region of Siberia, the Kitoi people routinely covered the dead in copious amounts of red ochre (Haüsler 1968, Michael 1958, Tolstoy 1958, Weber 1994). Derevyanko (1994:462) describes this process as 'lavish employment, which symbolized the living principle, the blood of the dead'. The

Lokomotiv site is the largest known Neolithic cemetery of the Baikal region on the left bank of the Angara River and at the mouth of the Irkut River. At Lokomotiv, Kitoi skeletal remains, grave goods, and the bottom of the burial pits were covered in red ochre (Bazaliiskii 2003). Similarly, all human remains and artifacts were covered in red ochre at another Early Neolithic cemetery Shamanka II located at the southernmost point of Lake Baikal (Figure 3.1), equal in size to Lokomotiv and also recently excavated by the Baikal Archaeology Project (Bazaliiskii, 2003).

Figure 3.1 Red ochre covered burial at Shamanka II in the Lake Baikal region (Photo V. Bazaliiskii).

The Serovo-Glazkovo culture group, who occupied the Baikal region from the Late Neolithic to Early Bronze Age (approximately 4200 to 1000 BC), also used red ochre in a

mortuary context but on rare occasions and then, not so profusely. The presence of red ochre at one Serovo-Glazkovo cemetery, Khuzhir-Nuge XIV (KN XIV), however, was not very convincingly demonstrated. In only a few cases were patches of reddish staining observed on a few skeletal elements (Burial Nos. 14 and 15 and possibly 21 and 31), an observation, which is consistent with most other Serovo-Glazkovo cemeteries. A few small concentrations of red ochre (approximately 5 to 10 cm in diameter) were located within the surrounding sediment in a few graves. It is not known at this time if these examples represent an intentional cultural activity or are a natural occurrence. It is well known that the Lake Baikal region includes many areas with large mineral deposits including iron ores so there likely would have been access to this resource nearby. However, if the presence of ochre is of a cultural origin its significance or reasons behind its use are not known.

Most discussions of ochre within the realm of anthropology concerns the symbolic nature of its use (Alinei 1981, Bolton 1980, Wreschner 1980). Red ochre, by virtue of being red, has been associated with blood, life, and joy (Wreschner 1980) thus tying it to death and mortuary ritual. It has also been suggested that red ochre was used for medicinal purposes due to the healing properties of the iron compounds, such as an astringent, antiseptic or deoderizor, treatment for burns, and an aid to stop hemorrhage (Keeley 1979, Velo 1984). Other uses include application of ochre to habitation sites, artifacts, and bodies (Marshack 1981, Miller 1980, Roper 1991, Stephenson 1980). It was used in leather tanning, as a wood preservative, and an abrasive for polishing stone,

ivory, or bone (Massett 1980, Roper 1991). Finally, as mentioned, the presence of red ochre may also be explained simply by its natural occurrence in the surrounding matrix. Researchers are sometimes quick to hypothesize about the reasons behind the use of ochre but surprisingly ochre itself has rarely been examined as a cultural taphonomic agent that has a direct impact on skeletal remains. Butzer (1980:635) pleads for a more responsible approach to the analysis and interpretation of "red" materials in the archaeological record before sociocultural significance is attached to them and Wreschner (1980:642) advocates the gathering of 'objective information' through 'controlled experiments'.

A study that did consider the taphonomic implications of ochre (McFarlane 2000) tested one logical and practical proposal for its mortuary use, that as a scavenger deterrent. The study arose from an event in Africa in the 1940s in which Kalahari tribesmen used ochre to ensure the protection of the burial of a British man after he died in military survival exercises. In the experiments, conducted by Alf Webb and Ian McFarlane, a total of seven lambs were buried in 1999 and 2000 in England, three covered in red ochre powder and four without. Fox had removed six of the seven burials from their pits suggesting that the ochre did little to protect the body from scavengers. However, certain factors may have also influenced the results such as the variable amounts of ochre used and the fact that the lambs were frozen prior to the experiment.

The study presented here examines the skeletal condition of domestic pigs (*Sus scrofa*) after they were subjected to red ochre. The research was developed as part of a

large project aimed at understanding the role of certain taphonomic factors, mainly cultural factors, at KN XIV. Three experiments were designed to ascertain if red ochre powder would alter the condition of the remains in terms of color (i.e. staining), completeness, articulation, and fragmentation (i.e. as determined by scavengers). With regard to color the following questions were considered: what is the color of the bone after one year? What is the extent and location of red ochre staining? Are there any factors that influence the staining, e.g. the concurrent use of fire in the grave (another characteristic of Siberian mortuary activity)? While the goal was to describe the effects of ochre treatment and not to speculate why red ochre has been applied to human remains in the past, the resulting completeness, articulation, and fragmentation of the experimental remains may provide clues as to why it was used.

3.2 METHODS

A replicate cemetery site was constructed at the Ellerslie Biological Field Station in Edmonton, Alberta, Canada. The area, a gently rolling morainal plain with fine-textured glaciolacustrine sediments, provided a large natural setting outside of the city. The site lays approximately 53°N latitude and 113°W longitude with an elevation of 686 meters above sea level. The average annual temperature range is approximately −14.1°C to 17.3°C, with mean monthly temperatures below freezing for 5 months of the year. Average annual precipitation is 450 mm (http://www.worldclimate.com).

Three domestic pigs (Nos. 20–22 of a total 22 experiments) were buried at the site between August 16–18, 2002. The use of domestic pigs as models for humans in taphonomy, decomposition, and forensic entomology experiments is well established as an adequate comparative model (Anderson and Cervenka 2002, Anderson and VanLaerhoven 1996 and 1999, Dillon 1997, France et al. 1992 and 1997, Haskell et al. 1997, Hewadikaram and Goff 1991, Janaway 1996, Komar 1999, Morton and Lord 2002, Payne and King 1968, Schoenly et al. 1991, Shean et al. 1993, Vance et al. 1995). Three pigs weighing approximately 45–50 kg each were supplied by an Edmonton area animal processing plant and were received no later than 48 hours after death. Therefore, the pigs were still considered fresh at the time of the experiments within the context of the mock burials.

Experimental graves (pits and burials) were constructed to conform to what is known of Serovo-Glazkovo graves at KN XIV. Three grave pits were dug using a backhoe at the exact dimensions of 214 cm x 68 cm, 214 cm x 68 cm, and 100 cm x 200 cm. The depth for each pit was 40 cm, the mean depth for all grave pits at KN XIV. The pits were placed c. 3 m apart. The pigs were laid in the pit with their heads to the west, in an extended supine position except Burial No. 20, which was resting on its right side. Grave pit dimensions and burial placement were generally the same as observed at KN XIV. Each pig was covered with 2.5 kg of iron oxide powder (98–100% Fe_2O_3). This amount was chosen in order to provide ample coverage over the entire body of the pigs (Figure 3.2). Powder was used in this study because it was reportedly used at many Paleolithic

sites as, for example, a piece of red ochre had been recovered at the *Homo erectus* shelter Becov, Czechoslovakia with abrasion striations indicating that it had been used in preparation of red ochre powder (Marshack 1981). Powder has also been used at many of the cemeteries at Cis Baikal (Tolstoy 1958). All but one of the graves (No. 22) were assembled with approximately 20–30 large (approximately 5 cm by 20–50 cm by 50–100 cm) and flat paving stones placed directly over the top of the burial forming a small cairn over the body (Figure 3.3). Grave No. 22 was backfilled in sediment.

Figure 3.2 Burial No. 20 covered in red ochre (Photo M. Weitzel).

Figure 3.3 Burial No. 21 covered with a stone cairn (Photo M. Weitzel).

The first experiment, Burial No. 20, was partially cremated and is also discussed in Chapter 2 dealing with the mortuary use of fire. In this experiment, a small fire of pine was built over the thoracic region of the pig and allowed to burn for approximately 3.5 hours in order to test if fire affected the impact of ochre on the skeletal remains.

Graves No. 20 and 21 were opened on August 26 and 25, 2003, respectively, approximately 1 year after burial. This period of time was chosen so that the bodies had reached an advanced or skeletonized stage of decomposition, thus allowing observation of changes to the bones (Galloway 1989). Decomposition stages were recorded using

Galloway et al.'s (1989) stages of decomposition. Skeletal and dental inventory forms were used to record color, completeness, articulation, and fragmentation. All of the burials were also photographed. The bodies were left inside the pits and reburied for future observations. The second experiment on Burial No. 22 was scavenged within 4 weeks after burial, thus prohibiting the collection of data described above.

3.3 RESULTS

Experiments are outlined in Table 3.1. Burial No. 20 was at an advanced stage of decomposition 1 year after burial. That is, the tissue was mummified with bone exposure of less than one half the skeleton. All bones were in articulation despite the presence of rodents as demonstrated by two rodent nests, one inside the rib cage and one in the abdominal area. The rodents were one of two types present at the Ellerslie site including house mouse (*Mus musculus*) or deer mouse (*Peromyscus maniculatus*) (Yvonne Kjorlien, personal communication). There was some gnawing of the sternal ends of a few ribs directly above one of the rodent nests (Figure 3.4). The red ochre stained the paving stones in contact with the pig, the sediment surrounding the pig, the wood used in the cremation experiment, and all tissue and bones that were initially exposed to the red ochre. A complete inventory of bones could not be recorded as many of them were still covered with tissue. Incidentally, the fire had a minimal impact on the skeleton, fracturing and possibly charring of a small number of the most distal left ribs.

Table 3.1 Experiments with red ochre and their characteristics.

Burial No.	Date of Burial	Date of Observation	Stage of Decomposition	Disturbance Type	Comments	Skeletal Condition
20	8/18/02	8/26/03	advanced	rodent	fire, cairn	fragment-ation
21	8/16/02	8/25/03	skeletonized	coyote or dog?	cairn	disartic-ulation
22	8/16/02	n/a (scavenged)	early/advanced?	coyote or dog?	backfilled	incomplete

Figure 3.4 Burial No. 20 ochre-stained ribs with rodent gnawing at sternal ends (Photo M. Weitzel).

On August 29, 2002 observations of Burial No. 22 showed that there had been little change since the time of the initial burial. On September 14, 2002 the burial had clearly been disturbed. One or more scavengers had taken the body of the pig some time during this approximately 2 week-interval between August 29 and September 14, 2002

(approximately 4 weeks after burial). Sediment from the pit had been dug out at both the west and east ends. All of the bones were removed leaving only small patches of ochre-stained sediment throughout the pit. It is likely that the pig was in an early to advanced stage of decomposition at this time, as the entire articulated body seems to have been removed as a whole. There was a red ochre path extending from the west end of the pit approximately 10 m to a stand of trees (Figure 3.5). The path ended within the trees where there was a 2 by 2 m area of vegetation covered in red ochre. Vegetation, here and along the path, was also pressed down likely due to a reasonably large animal dragging the pig. No pig remains were found along the path or in the stand of trees. Dog or coyote scat was located approximately 50 cm north of the pit. Both of these animals have been observed at the site (personal communication, Yvonne Kjorlien).

Figure 3.5 Red ochre path extending from Burial No. 22 to approximately 10 m west of pit (Photo M. Weitzel).

Burial No. 21 was skeletonized, that is, bones were exposed and desiccated or mummified tissue covered less than one half of the skeleton. The burial was also disturbed as at least one small stone was turned over with the ochre side facing up and several ochre-stained bones were exposed. In addition, bones and stained sediment were transported approximately 50 cm north of the pit including one vertebra and the right innominate bone. Otherwise the bones appeared to be in articulation. There was no indication of gnawing or fracturing of the bones. Once again a complete inventory of bones could not be recorded as there was a maggot mass over and inferior to the pelvic region. All bones visible inside and outside of the pit were stained red.

3.4 DISCUSSION

3.4.1 COLOR

The experiments demonstrated that at least 2.5 kg of red ochre placed over a body that is subsequently buried, either with stone slabs or fine sediment, will stain the bone and mummified tissue as well as the matrix that underlies it, some time prior to one year. The color of the ochre-stained bones in Burials No. 20 and 21 was dark red (10R3/6), the same as the original ochre powder (Munsell 1992). In most cases, staining covered both sides of each bone beyond just the ventral aspects, even though the ochre was initially only sprinkled over this part of the body (with the exception of Burial No. 20, in which ochre was sprinkled over the right side). In addition, the ochre stain penetrated the entire depth of both the compact and trabecular bone of many skeletal elements. Staining occurred despite the stage of decomposition of the remains and faunal and insect disturbances. The application of fire to the ochre-covered body appears to have no additional impact on staining as the color of bone in this experiment was similar to the experiment that was not exposed to fire. Color will continue to be monitored over time and any changes in ochre staining will be recorded.

3.4.2 COMPLETENESS, ARTICULATION, AND FRAGMENTATION

All skeletal elements of both Burials No. 20 and 21 appeared to be complete when observed. However, one or possibly more animals removed the entire pig in Burial No. 22. Although, the presence of ochre likely did not cause the transport of the pig by luring

the scavenger to it, neither did it serve to deter scavengers. The same can be said with regard to articulation and fragmentation. Skeletal elements of Burial No. 20 and likely Burial No. 22 were in articulation one year after burial but Burial No. 21 was disarticulated, likely a result of rodent activity. Burial No. 20 was also fragmented as a result of rodent gnawing. Therefore, skeletal condition (as it was observed through completeness, articulation, and fragmentation) was influenced by animals despite the presence of red ochre.

One potential use of ochre, scavenger deterrent or insect deterrent, can perhaps be eliminated as a result of these three experiments. Because each of the three burials were disturbed either by insects, rodents, and/or coyote(s) or dog(s) it appears that the presence of red ochre did little to deter insect or other faunal activity. Even if people presumed that ochre was a deterrent they would have eventually seen evidence to the contrary, that is disturbed burials, and discontinued the practice if this was the sole reason for using it.

3.5 CONCLUSIONS

Applying the experimental evidence to the instances of ochre in the graves at KN XIV, it does not seem likely that ochre was part of the Serovo/Glazkovo mortuary process, in the sense of body preparation, as it was among Kitoi peoples. Perhaps ochre was intentionally placed in the grave but due to the very few examples of staining on the bones it is doubtful that bodies were purposefully covered in ochre. It is also possible that the staining on the bone is of a geological origin supported by the fact that there are

small patches red ochre in the grave pit that may be natural occurrences of iron-rich sediment or decomposing bedrock. However, when bone is stained reddish at KN XIV, i.e. Burial No. 14, the sediment surrounding the bone does not appear reddish. Conversely, when there is a patch of ochre-stained sediment at KN XIV, the bones themselves were not stained red. Unfortunately, samples of these red ochre-like concentrations in the matrices were not taken. Therefore, addressing this issue through geochemical analysis is no longer possible. It is likely that the red staining of sediment is a natural occurrence. The red color of the bone must be a product of something other than sprinkling over the body as in the case of the Kitoi such as ochre-dyed clothing or pouches of ochre buried with the individual. The use of ochre at KN XIV if at all cultural was not like that used among Kitoi and it's quite possible that ochre was not used at KN XIV at all.

Finally, through this relatively small actualistic study I also learned what can be accomplished in similar future experiments. Additional experiments should consider the following: 1) using different types of ochre e.g. brown and yellow ochre of varying trace elements, which will help to determine if ochres that vary geochemically will stain skeletal remains similarly and if not, how their effects may differ; 2) testing the effects of ochre in forms other than powder, such as pastes; 3) varying the amounts of ochre applied, e.g. using less than 2.5 kg to determine how much is necessary for staining to occur; 4) monitoring the experiments closer, which will help to determine at what point in time staining occurs in relation to the amount applied; continued monitoring will also

determine the lasting effects of ochre stain, e.g. is there a period in time when the ochre begins to fade; 5) burying pigs in iron-rich matrices may help to distinguish which environments (i.e. sediment types) contribute to staining of bone and how these compare to pigs exposed to ochre through cultural agents, finally; and 6) testing of other potential uses of red ochre in mortuary contexts, e.g. leather tanning and testing the influence of ochre dyed garments would also be of interest, e.g. does the tanning or dyeing of leather clothing with red ochre result in staining of skeletal remains? If so, could this be the reason for red ochre on certain prehistoric burials?

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4. HUMAN TAPHONOMY AND GRAVE ARCHITECTURE

4.1 INTRODUCTION

Treatment of the dead has always attracted wide anthropological interest. Bodies are disposed of in a variety of ways in prehistoric as well as contemporary forensic contexts. Much meaning and importance has been assigned to these choices of deposition by archaeologists, forensic investigators, and the like. Often conclusions are drawn about the mortuary context without mention of the taphonomic agents that can play a vital role in most burial environments, as demonstrated by the general lack of cultural taphonomic studies. Grave architecture, which can be broadly defined as the immediate environment surrounding the burial whether or not it is a formal grave, has an important function in taphonomy. Burials placed on the earth's surface will be subjected to different taphonomic agents than those in coffins, on scaffolds, buried deep below the earth's surface, placed in water, etc. These decisions that humans make in disposal of the dead will have lasting consequences for the condition of the human remains and thus, are an important topic for consideration.

This paper investigates the way in which grave architecture influences decomposition and skeletal condition. Specifically, the objective was to ascertain whether rates of decomposition, and completeness, articulation, and fragmentation of the skeletal remains are affected by the following attributes of the grave: the type of grave architecture (described in detail below); the size of the pit including length, width, and depth; and the number of stones placed over the body when stone cairns are constructed over the burial.

The study was developed primarily to learn more about taphonomy at Khuzhir-Nuge XIV (KN XIV), a Late Neolithic/Early Bronze Age cemetery in the Lake Baikal region of Siberia. The burials at KN XIV displayed a range of variability both in the differential preservation observed in the remains as well as variables characterizing the remains such as age, sex, location of graves, etc. while all surface variables appeared relatively similar.

4.2 METHODS

There were 74 graves with 84 burials at KN XIV. The graves were distinguished within the site as clusters of flat stones. Clusters were usually oval in shape, ranging from 2–3 meters by 3–5 meters and were flat or slightly mounded (Figure 4.1). The stones formed a small cairn over the body usually with a deliberately excavated pit underneath. The depth of each grave was approximately 25 to 85 cm below surface. Grave pits were often filled or lined vertically with stones.

With some exceptions, the burials were usually situated with the head pointing west in an extended supine position (Figure 4.2). Arms were extended at the side of the body, resting on or tucked beneath the pelvis, or bent resting on the abdomen. Burials were usually single, however, there were also double (n=7) and triple (n=2) burials. Most burials were primary interments, although as many as five burials may have been secondary based on evidence of disarticulation prior to interment.

Figure 4.1 Architecture of Grave No. 68, Khuzhir-Nuge XIV (Photo A. Weber).

Figure 4.2 Burial No. 68, Khuzhir-Nuge XIV (Photo A. Weber).

Previous research at KN XIV identified the various taphonomic processes involved in the resulting skeletal condition (Lieverse 1999, 2000). The purpose of Lieverse's research was to explore the relationships between completeness, articulation, and fragmentation of skeletal elements and a number of independent variables including some related to grave architecture. It should be mentioned that Lieverse's study includes graves excavated in the years 1997–1998. These graves were mostly intact, while many of the graves excavated in 2000–2001 were disturbed. Therefore, the results of Lieverse's study do not expound on the patterns found in disturbed graves. The independent variables were burial depth; total number of small (<15 cm), medium (15–30 cm), and large (>30 cm) stones per square meter of the grave pit; and grave pit area in square

meters. Lieverse (1999, 2000) found that burial depth was significantly associated with completeness, fragmentation, and articulation. The deeper the individual was buried the more likely it was to be complete and articulated, and less likely to be fragmented. The number of small, medium, and large stones was significantly associated with completeness and fragmentation. The more stones of each size, the more likely skeletal elements were complete and less likely to be fragmented. Grave pit area was also significantly associated with completeness and fragmentation. Skeletal elements from large pits were more complete and less fragmented than those from small grave pits. Lieverse ultimately concluded that general skeletal condition is attributed to cultural factors that had yet to be identified. The investigation presented here sought to learn more about the relationship between taphonomy and grave architecture but used data collected at KN XIV to develop actualistic experiments.

The experimental site is located at the Ellerslie Biological Field Station in Edmonton, Alberta, Canada. The area, a gently rolling morainal plain with fine-textured glaciolacustrine sediments, provided a large natural setting outside of the city. The site lays approximately 53°N latitude and 113°W longitude with an elevation of 686 meters above sea level. The average annual temperature range is approximately −14.1°C to 17.3°C, with mean monthly temperatures below freezing for 5 months of the year. Average annual precipitation is 450 mm (http://www.worldclimate.com). Transient human impact to the site is minimal but the presence of birds, rodents, dogs, coyotes, and deer have been recorded at the site (Yvonne Kjorlien, personal communication). A total

of nine domestic pigs (*Sus scrofa*) were buried at the site on May 24 and 31, 2002 (Burials no. 1–9 of the total 22 experiments, Table 4.1).

The use of domestic pigs as models for humans in taphonomy, decomposition, and forensic entomology experiments is well established as an adequate comparative model (Anderson and Cervenka 2002, Anderson and VanLaerhoven 1996 and 1999, Dillon 1997, France et al. 1992 and 1997, Haskell et al. 1997, Hewadikaram and Goff 1991, Janaway 1996, Komar 1999, Morton and Lord 2002, Payne and King 1968, Schoenly et al. 1991, Shean et al. 1993, Vance et al. 1995). Pigs used in this investigation were donated by an Edmonton area animal processing plant and had not been dead for more than 48 hours. Therefore bodies were still considered fresh at the time of burial in the context of the mock burials. The weight of each pig was approximately 45 kg except for the pig used in Burial No. 9, which was approximately 25 kg.

Table 4.1 Experimental grave attributes (all measurements are in cm).

Attributes	Burial No. 1	Burial No. 2
Length of Pit	214	214
Width of Pit	68	68
Depth of Pit	40	40
Pit Lining	yes	yes
Weight of Pig	45 kg	45 kg
Burial Position, May 2002	extended, supine	extended, supine
Burial Position, August 2002	extended, supine	extended, supine
Burial Position, August 2003	extended, supine	extended, supine
Burial Orientation, May 2002	head west, facing north	head west, facing south
Burial Orientation, August 2002	head west, facing northwest	head west, facing north
Burial Orientation, August 2003	head west, facing west	head west, facing northwest
Stage of Decomposition, August 2002	C	C
Stage of Decomposition, August 2003	C	C
Burial Depth, May 2002	15	18
Burial Depth, August 2002	30	31
Burial Depth, August 2003	33	unknown
Type of Cover	cairn	cairn
Length of Cairn	205	214
Width of Cairn	62	68
No. of Stones, May 2002	31	30
No. of Stones, August 2003	28	39
Faunal Disturbance, August 2002	n/a	>5 rodents, nest between legs
Faunal Disturbance, August 2003	rodent nest between legs	n/a
Comments	n/a	clothing

Table 4.1 Experimental grave attributes (all measurements are in cm; Con't.).

Attributes	Burial No. 3	Burial No. 4
Length of Pit	214	214
Width of Pit	68	68
Depth of Pit	40	40
Pit Lining	no	yes
Weight of Pig	45 kg	45 kg
Burial Position, May 2002	extended, on side (leaning north)	extended, on side (leaning north)
Burial Position, August 2002	extended, on side (leaning north)	extended, on side (leaning north)
Burial Position, August 2003	unable to determine	extended, on side (leaning north)
Burial Orientation, May 2002	head west, facing north	head west, facing north
Burial Orientation, August 2002	head west, facing northwest	head west, facing west
Burial Orientation, August 2003	unable to determine	head west, facing north
Stage of Decomposition, August 2002	C	C
Stage of Decomposition, August 2003	unable to determine	C
Burial Depth, May 2002	13	18
Burial Depth, August 2002	35	34
Burial Depth, August 2003	unable to determine	unknown
Type of Cover	sediment	cairn
Length of Cairn	n/a	211
Width of Cairn	n/a	73
No. of Stones, May 2002	n/a	60
No. of Stones, August 2003	n/a	62
Faunal Disturbance, August 2002	1 mouse seen	rodent nest in thoracic region
Faunal Disturbance, August 2003	n/a	n/a
Comments	pig scavenged	n/a

Table 4.1 Experimental grave attributes (all measurements are in cm; Con't.).

Attributes	Burial No. 5	Burial No. 6
Length of Pit	214	214
Width of Pit	68	68
Depth of Pit	40	65
Pit Lining	yes	yes
Weight of Pig	45 kg	45 kg
Burial Position, May 2002	extended, on side (leaning south)	extended, supine (slightly south)
Burial Position, August 2002	extended, on side (leaning south)	extended, supine (slightly south)
Burial Position, August 2003	extended, on side (leaning south)	unknown
Burial Orientation, May 2002	head west, facing south	head west, facing west
Burial Orientation, August 2002	head southwest, facing southwest	head west, facing west
Burial Orientation, August 2003	unable to determine	head west, facing SW
Stage of Decomposition, August 2002	C	D
Stage of Decomposition, August 2003	C	D
Burial Depth, May 2002	16	40
Burial Depth, August 2002	36	60
Burial Depth, August 2003	unknown	unknown
Type of Cover	cairn	cairn
Length of Cairn	158	223
Width of Cairn	65	97
No. of Stones, May 2002	22	53
No. of Stones, August 2003	21	54
Faunal Disturbance, August 2002	n/a	n/a
Faunal Disturbance, August 2003	yes?	n/a
Comments	scavenged	n/a

Table 4.1 Experimental grave attributes (all measurements are in cm; Con't.).

Attributes	Burial No. 7	Burial No. 8
Length of Pit	214	260
Width of Pit	68	125
Depth of Pit	20	65
Pit Lining	yes	yes
Weight of Pig	45 kg	45 kg
Burial Position, May 2002	extended, supine (slightly south)	extended, supine
Burial Position, August 2002	extended, supine (slightly south)	extended, supine
Burial Position, August 2003	extended, supine (leaning south)	unknown (skull is prone)
Burial Orientation, May 2002	head west, facing west	head west, facing south
Burial Orientation, August 2002	head west, facing west	head west, facing south
Burial Orientation, August 2003	head west, facing west	head west, facing southwest
Stage of Decomposition, August 2002	C	D
Stage of Decomposition, August 2003	C	D
Burial Depth, May 2002	24	55
Burial Depth, August 2002	unknown	unknown
Burial Depth, August 2003	unknown	unknown
Type of Cover	cairn	cairn
Length of Cairn	214	316
Width of Cairn	112	203
No. of Stones, May 2002	32	75
No. of Stones, August 2003	26	unknown
Faunal Disturbance, August 2002	n/a	n/a
Faunal Disturbance, August 2003	rodent nest at neck, gnawing	n/a
Comments	n/a	vaulted cairn

Table 4.1 Experimental grave attributes (all measurements are in cm; Con't).

Attributes	Burial No. 9
Length of Pit	95
Width of Pit	40
Depth of Pit	50
Pit Lining	yes
Weight of Pig	25 kg
Burial Position, May 2002	extended, supine
Burial Position, August 2002	unknown
Burial Position, August 2003	extended, supine
Burial Orientation, May 2002	head west, facing west
Burial Orientation, August 2002	unknown
Burial Orientation, August 2003	head west, facing ?
Stage of Decomposition, August 2002	D
Stage of Decomposition, August 2003	D
Burial Depth, May 2002	25
Burial Depth, August 2002	38
Burial Depth, August 2003	unknown
Type of Cover	cairn
Length of Cairn	126
Width of Cairn	70
No. of Stones, May 2002	19
No. of Stones, August 2003	23
Faunal Disturbance, August 2002	n/a
Faunal Disturbance, August 2003	n/a
Comments	n/a

Because the graves were initially constructed in order to learn about activities that occurred at KN XIV, the construction conformed to that site as closely as possible (Figure 4.3). Grave pits were dug using a backhoe at a length of 214 cm and width of 68 cm, except pits for Burial No. 8 at 260 cm by 125 cm, and Burial No. 9 at 95 cm by 40 cm. The depth was 40 cm deep except pits for Burials No. 6 and 8 at 65 cm, Burial No. 7 at 20 cm, and Burial No. 9 at 50 cm. All but one of the graves was constructed with approximately 19–32 large (approximately 5 cm by 20–50 cm by 50–100 cm) and flat paving stones placed directly over the top of the burial forming a cairn over the body. Graves for Burials No. 4, 6, and 8 were built with 53–75 stones. The length of the stone cairn ranged from 126 to 316 cm and the width from 62 to 203 cm. All pits that were covered with a cairn were also lined inside with stones around the perimeter. One grave was built so that the cairn was suspended across the top of the pit without direct contact to the pig (Burial No. 8). Another grave (Burial No. 3) was backfilled with sediment in order to compare the burial in this grave with those covered in stone.

Figure 4.3 Architecture of experimental graves both prior to and after deposition of the pig (Photo M. Weitzel).

The pigs were oriented with their head at the west end of the pit, however, the direction they were facing varied (Figure 4.4). Pigs were laid in an extended, supine position except for Burials No. 6 and 7, which were leaning slightly south and Burials No. 3, 4, and 5, which were on their sides facing either north or south. The depth of the top of the thoracic region of the pig from the top surface of the pit ranged from 13 to 55 cm. All pigs were buried without clothing; Burial No. 2 was the only clothed one, dressed in a fur coat and beaded leather booties covering the hind feet/hooves. Though clothing is not a characteristic of grave architecture, Burial No. 2 was initially developed to test the impact of clothing on skeletal condition.

Figure 4.4 Experimental Burial (Photo M. Weitzel).

The graves were opened on August 28 and 29, 2002, 3 months after burial for examination, then closed, and reexamined one year after the original burial on August 26 and 28, 2003. During each examination decomposition was recorded using Galloway et al.'s (1989) stages of decomposition. Skeletal condition, which included completeness, articulation, and fragmentation of skeletal elements was also recorded. Any significant changes to the burial, pit, cairn, or surrounding area were noted. Burials were also photographed. The bodies were not removed; instead they were reburied for future observations.

4.3 RESULTS

4.3.1 BURIAL NUMBER 1

Burial No. 1 (Table 4.1) was initially constructed as the control burial in the sense that the grave was built with a cairn using the average dimensions of all Glazkovo graves. The burial featured an unclothed pig of approximately 45 kg. The other eight graves/burials were constructed with at least one variable that differed from this grave/burial, the variable(s) being tested.

4.3.1.1 3 MONTHS AFTER BURIAL

Burial No. 1 was in an advanced stage of decomposition 3 months after burial, that is there was mummification of tissue with bone exposure of less than one half of the skeleton and moist decomposition throughout much of the burial. Exposed bones were

stained dark brown from the surrounding sediment and included most of the maxilla and mandible, a few upper right ribs, the bones of the right lower front leg and hoof, parts of the lumbar vertebrae, both innominate bones, and heads of the femora. There was some collapse of sediment into the pit from the walls on the east end perhaps aiding in the preservation of the back legs and hooves. The right ear was also preserved as desiccated tissue. Hair was still attached to much of the remaining tissue. The position of the burial remained the same except that the head, originally facing north, was facing more to the northwest. The depth between the surface and the top of the burial increased 15 cm after 3 months due to body decomposition.

4.3.1.2 1 YEAR AFTER BURIAL

One year after burial the pig was at the same stage of decomposition as that recorded at the 3–month interval. Some mold had grown on the jaw and front leg bones. Some of the maxillary and mandibular incisors were disarticulated. The head was facing even more toward the west than it was 3 months after burial. A rodent nest was located between the lower legs. The depth of the burial increased another 3 cm since the previous observation. The number of stones in the cairn decreased after one year by three, either a result of humans removing the rocks or a possible original miscount.

4.3.2 BURIAL NUMBER 2

Though clothing is not a characteristic of grave architecture, Burial No. 2 (Table 4.1) was initially developed to test the impact of clothing on skeletal condition. All other characteristics matched that of Burial No. 1. The lining of the coat was removed prior to burial.

4.3.2.1 3 MONTHS AFTER BURIAL

Three months after burial the fur from the coat (possibly rabbit) was still preserved but the thread that it was originally attached to was not. The leather booties were preserved with the brightly colored beading still apparent. The burial was in an advanced stage of decomposition after 3 months as nearly the entire pig was mummified and covered in empty insect pupal casings. The direction the head was facing moved from south to north. At least five mice were seen scattered in the east end of the pit as the stones were lifted and there was a nest between the back legs that appeared to be made of fur from the coat (Figure 4.5). The mice were one of two types present at the Ellerslie site including house mouse (*Mus musculus*) or deer mouse (*Peromyscus maniculatus*) (Yvonne Kjorlien, personal communication). The depth between the surface and the top of the burial increased by 13 cm.

Figure 4.5 Mummified tissue of Burial No. 2, preserved booty, and rodent nest (Photo M. Weitzel).

4.3.2.2 1 YEAR AFTER BURIAL

The pig was still at an advanced stage of decomposition one year after the original burial. However, more of the bone was exposed at this time including most of the skull,

some of the thoracic vertebrae, and the lower leg bones. Decomposition was moist and there was some mold in the pelvic region and in and around the booties. The head was facing slightly further west than at 3 months after burial, now lying northwest. The depth of the burial was not measured at this time. The number of stones increased by nine since the initial construction of the cairn probably due to a result of breakage through time.

4.3.3 BURIAL NUMBER 3

Burial No. 3 (Table 4.1) was filled with sediment as opposed to being covered with stones.

4.3.3.1 3 MONTHS AFTER BURIAL

This pig was also in an advanced stage of decomposition 3 months after burial, mummified but with some retention of internal structures. The head was mummified with moist tissue underlying the skin. The mandible was exposed, as were some ribs, the right front leg, and a few tarsals. Flesh was preserved among the vertebrae, pelvis, and lower legs. The position of the head moved west from its original north facing. The depth between the surface and the top of the burial increased by 16 cm over the 3 months.

On September 14, 2002, approximately 3 months after burial (2 weeks after it was exposed for observations), the pig was disturbed. The sediment had been dug out at both the west and east ends of the pit and skeletal elements and tissue were scattered in all directions outside the pit as far as 4 m away. Dog or coyote scat was located

approximately 150 cm north of the west end of the pit. Both animals have been observed at the site (Yvonne Kjorlien, personal communication).

4.3.4 BURIAL NUMBER 4

Burial No. 4 (Table 4.1) was developed to test the impact of a cairn with 60 stones placed over the burial, which is approximately 28–41 more stones than all other experimental graves.

4.3.4.1 3 MONTHS AFTER BURIAL

The burial was in an advanced stage of decomposition after 3 months, mummified with very little bone exposed and moist decomposition in the thoracic and abdominal region. Exposed bones included the mandible, parts of both front legs, and parts of the pelvis. The cranium was fragmented in several places but appeared to be lying in its original northern orientation. One rodent was seen inside the pit as the stones were removed. The depth between the surface and the top of the burial at this time was 22 cm deeper than when it was initially deposited.

4.3.4.2 1 YEAR AFTER BURIAL

One year after burial the stage of decomposition was still unchanged relative to the condition of the 3–month interval. A rodent nest was located under the stones in the thoracic region of the burial. There were two additional stones making up the cairn.

4.3.5 BURIAL NUMBER 5

Burial No. 5 (Table 4.1) was constructed to test the impact of a cairn made of 22 stones, approximately 22–41 less stones than all other graves.

4.3.5.1 3 MONTHS AFTER BURIAL

The burial was in an advanced stage of decomposition after 3 months, with most of the body mummified, including a mummified left ear. The maxilla and mandible were exposed, as were the distal end of the left radius, the back legs, and the tarsal and metatarsals. The direction the head was facing moved slightly west from its original southern orientation. The depth between the surface and the top of the burial had increased by 20 cm.

4.3.5.2 1 YEAR AFTER BURIAL

One year after burial, the stage of decomposition appeared to be the same as that recorded at the 3–month interval. The burial had been disturbed by animals at some time over the course of the 9 months since the first observation. Only the rib cage, pelvis, and proximal ends of the lower legs remained. There was one less stone counted in the cairn at this time.

4.3.6 BURIAL NUMBER 6

Burial No. 6 (Table 4.1) was constructed with a greater average depth of 65 cm, which is approximately 25 cm deeper than the other graves.

4.3.6.1 3 MONTHS AFTER BURIAL

This pig was skeletonized 3 months after burial, with mummified tissue covering less than one half of the skeleton. The mummified regions included parts of the skull, the pelvis, and the left back leg. The bones were covered in white mold except the ribs where the stone was in direct contact with the bone. The head was facing slightly more to the south than its original western orientation. The depth between the surface and the top of the burial had increased 20 cm since it was originally deposited.

4.3.6.2 1 YEAR AFTER BURIAL

One year after burial, the pig was unchanged relative to the condition recorded at the 3–month interval. There was still white mold but there was also an additional bright yellow mold. There was one additional stone since the initial construction of the cairn.

4.3.7 BURIAL NUMBER 7

Burial No. 7 (Table 4.1) was built with a shallower pit only 20 cm, approximately 20 cm less than other graves.

4.3.7.1 3 MONTHS AFTER BURIAL

The stage of decomposition was advanced. Tissue of the pig was almost entirely mummified with only three lower left ribs, three lumbar vertebrae, and parts of the lower legs exposed. The depth between the surface and the top of the burial was not recorded at this time.

4.3.7.2 1 YEAR AFTER BURIAL

After one year, the stage of decomposition did not change from the 3-month interval but there was increased skeletonization of the ribs and lower vertebrae. A rodent nest was located on the neck region and rodent gnawing on the right patella. Six fewer stones were counted since the original construction.

4.3.8 BURIAL NUMBER 8

Burial No. 8 (Table 4.1) varied in that the pit was much larger in dimension, 260 cm by 125 cm, 46 cm longer and 57 cm wider than the other grave pits. The cairn was also built vaulted over the top of the pit without having contact directly with the pig in order to evaluate if there would be any differences in the effects.

4.3.8.1 3 MONTHS AFTER BURIAL

After 3 months the pig was skeletonized but extremely wet. The skull had split along the sutures and parts of the skull retained tissue. Some tissue over the vertebrae, parts of

the back legs, and bones of both sets of hooves were mummified. The head faced slightly more west than its original south facing. The depth between the surface and the top of the burial was not recorded at this time.

4.3.8.2 1 YEAR AFTER BURIAL

One year after burial the pig was slightly more skeletonized than it was at the 3–month interval. The cairn had collapsed some time prior to this observation and the stones were situated with an opening to the pit (about 50 cm in diameter). Some skeletal elements were missing. The position of the skull had changed so that it was turned upside down with the mandible resting on top. Stones were not counted at this time.

4.3.9 BURIAL NUMBER 9

Burial No. 9 (Table 4.1) differed in both the size of the pig (approximately half the size of the others) and the pit dimensions. The pit dimensions, 95 cm by 40 cm, were 119 cm shorter and 28 cm narrower than all other graves.

4.3.9.1 3 MONTHS AFTER BURIAL

The pig was skeletonized and covered in white mold after 3 months with some mummification of tissue on the skull. The skull had fractured along suture lines. Sediment from the walls of the pit had collapsed and filled most of the pit surrounding

the bones. The depth between the surface and the top of the burial increased 13 cm since its original deposition.

4.3.9.2 1 YEAR AFTER BURIAL

One year after burial all bones were skeletonized. The sediment had filled the pit forming layers between the stones. The number of stones had increased by four.

4.4 DISCUSSION

4.4.1 STAGE OF DECOMPOSITION

Two stages of decomposition were represented by the burials, advanced (n=6, Burial Nos. 1–4, 5, and 7) and skeletonized (n=3, Burial Nos. 6, 8, and 9) and among all of them, the stages did not change between 3 months and 1 year after burial. Burial No. 6 was buried at 65 cm as opposed to the mean of 40 cm. Burial No. 8 was buried in a large pit also 65 cm deep with a cairn vaulted over the top, and Burial No. 9 was a much smaller pig in a relatively small pit 50 cm deep. This suggests that the deeper the burial, the faster the rate of decomposition. However, the fact that Burial No. 9 was a much smaller pig undoubtedly also influences the rapid rate of decomposition as bodies of children often decompose faster due to the relatively smaller surface area (Morton and Lord 2002) and at 25 kg this pig was closer to the size of a child or sub-adult than an adult.

It is also important to note that Burials No. 6 and 8 had relatively more stones placed upon them, which could help to account for their advanced decay. It is difficult to say whether or not the vaulted cairn played a role in speeding up decomposition. Possibly the extra space created by suspending the cairn over the body again trapped heat inside the pit increasing the rate of decomposition.

Correlated with the stage of decomposition, was the increase in the depth between the top of the burial and earth's surface (or the top of the pit). After 3 months the mean increase in depth was 17 cm. The greatest increase in depth was 22 cm (Burial No. 4) and the least was 13 cm (Burials No. 2 and 9). Burial No. 4 had the greatest number of stones lying over the top of it, resulting in more pressure upon the pig, thus likely flattening the body more rapidly during decomposition than any other burial. The depth of Burial No. 9 did not increase as much due to the relatively few number of stones correlated with the smaller size of the pit and pig. It is uncertain why Burial No. 2 had a relatively small increase in burial depth. Perhaps clothing played a role by protecting the thoracic region, thus slowing the decay process, and keeping the stones from compressing it right away. Clothing has been reported as both increasing rates of decomposition by protecting maggots from sunlight (Mann et al.1990), and decreasing rates of decomposition by protecting underlying tissue from animals, wind, rain, and sunlight (Galloway et al. 1989, Komar 1999).

4.4.2 COMPLETENESS

Data on completeness, articulation, and fragmentation were recorded as much as possible, recognizing that these variables may be archaeologically more relevant as time passes and the soft tissue continues to decompose. Skeletal completeness of the burials was not altered except in the case of Burials No. 3, 5, and 8, the only three pigs missing skeletal elements. Animal activity seems to explain the absence of elements best. In each of these experiments the grave architecture allowed access to the body by predators.

Burial No. 3, the only one covered in sediment rather than stone, was scavenged after the first observation. It is much easier for an animal to move sediment than it is to move large stones. Whether or not the burial would have been scavenged had it not been opened for observation, thus releasing the odor of decomposing remains, is not known. However, other pigs buried in sediment that were not used in this particular study were also scavenged without having been opened previously.

Burial No. 5 was built with only 22 stones covering it (the mean of the other seven experiments was 42 stones) thus leaving many openings between the stones for insects and small animals to enter. Similarly, although Burial No. 8 had many stones covering it, when the cairn eventually collapsed (it is believed naturally, due to the large number of stones and precarious way they balanced on top of the pit) it formed an opening in the stones in which intruders could pass. The skeleton in Burial No. 8 was complete at the first observation. At the second observation bones were missing. From the results of the experiments it appears that certain architectural patterns of the grave are conducive to

scavenging, that is where stones are arranged in a particular way or the pit is filled with sediment.

Lieverse (1999, 2000) found that completeness was significantly associated with burial depth, the number of stones, and grave pit area. As each of these factors increased so too did completeness of the individual. In the case of the experiments, burial depth was associated with an accelerated rate of decomposition but other causal factors must also be considered, as discussed above. It is difficult to determine if increased depth continues to advance decay for thousands of years influencing completeness of skeletal elements through time. The incomplete pigs were of both deep and shallow burials but as mentioned above completeness likely has more to do with the remains being more accessible to animals by grave type than burial depth alone.

Lieverse (1999, 2000) also demonstrated that at KN XIV completeness of skeletal elements increased with the number of stones. This was supported by one of the experiments in which the burial with the least amount of stones used in construction was one of the three scavenged, consequently more incomplete. It is thus possible that at KN XIV too it is scavenging activity in association with the number of stones that accounts for the incomplete burials.

Finally, grave pit area varied among incomplete burials, although one of the incomplete burials was the one with the largest pit (Burial No. 8). This is incongruent with Lieverse's (1999, 2000) results, which found completeness to increase with pit size. Again, it should be noted that her results are from mostly undisturbed burials, while

results from this study include both disturbed and undisturbed burials. It is probably true that the larger and deeper the grave pit the more likely remains are to be complete. Completeness probably has less to do with pit size in this case than it does grave type, i.e. the collapse of the vaulted cairn opening the grave to scavengers.

4.4.3 ARTICULATION

Lieverse (1999, 2000) found that articulation was significantly associated with burial depth. The deeper the burial the more likely it was to be articulated. Results from the experiments do not support or refute Lieverse's results since all burials were in articulation aside from the disarticulation of some teeth from the jaws after a year. The disarticulation of teeth could be the result of natural decomposition, insect and rodent activity, or both. This is not to say, however, that there was no movement of bones. The orientation of the head (the direction it was facing) changed from its original orientation in six of nine burials within the 3 months after they were deposited. This is likely due to natural collapse during decomposition in which there was ample space in the grave pit possibly aided by animal disturbances. This could be important when applied to human remains, where the direction individuals are facing is often given cultural meaning based on the assumption that it was not altered by taphonomic processes.

4.4.4 FRAGMENTATION

Fragmentation among burials was minimal and limited to the skull of Burials No. 4, 9, and 10. Fragmentation, involving splitting along the sutures, suggested that it was mainly a result of natural decomposition and ample space surrounding the skull. Lieverse (1999, 2000) found that fragmentation was significantly associated with burial depth, number of stones, and grave pit area. The three experiments displaying fragmentation were buried at three different burial depths, with a variable number of stones over the top of them, and differing grave pit areas so these factors are probably not what accounted for the fact they were fragmented.

It should also be mentioned that the grave itself underwent some notable changes through time. Some of the sediment surrounding many of the burials collapsed into the pit. However, sediment came in contact with the pig in only two graves (Burials No. 1 and 8). The sediment around Burial No. 8 formed layers between the stones similar to that seen at KN XIV. The collapse of the sediment was probably a result of natural colluvial and aeolian transport but may also have been triggered further by movement of animals such as rodents inside the pit or dogs or coyotes near the pit. In addition, the number of stones changed slightly over the course of the year. Occasionally the number of stones increased. This is likely due to breakage as graves were opened and stones were removed. There are also cases in which fewer stones were counted after the initial construction of the grave. This could be due to an initial miscount or removal of stones by the few visitors who may have come to the site.

4.5 CONCLUSIONS

Certain aspects of grave architecture may influence the future state of the remains. The experiments demonstrated that the depth of the pit and the number of stones used in cairn construction do affect rates of decomposition. The type of grave (sediment-filled, cairn covered, and a vaulted cairn) and the number of stones used in cairn construction may affect access to the burial by insects and small animals and thus completeness and articulation. The dimensions of the pit may have also aided in slightly altering the position of the skulls in the sense that the size of the pit allowed for movement through natural decomposition. Fragmentation was not influenced by grave architecture in the experiments but was due to natural decomposition. Finally, the grave architecture alone also changes over time. These results show that despite the relatively large temporal gap between the experimental graves and graves at KN XIV the taphonomic influences relating to the grave architecture discussed above may be similar. Animal activity that is controlled by the architecture of the grave is an important taphonomic agent. Completeness, fragmentation, and articulation of skeletal remains at KN XIV could have been altered in similar ways to those of the experiments.

Grave architecture is also a topic of a Master's thesis at the University of Alberta by Bradley Drouin. Although the thesis has little to do with skeletal condition, it is likely to identify more variability in grave attributes, which have not been previously considered

with regard to taphonomy. Future research could use this data to construct new experiments testing the effects of these new attributes.

The experiments presented here are by no means complete but rather a work in progress as more changes to grave architecture and the burial as a result of the architecture are likely to occur through time. However, even in this early stage the study has shown that the composite attributes that make up the architecture of the grave serve as taphonomic agents that potentially alter skeletal condition either directly or indirectly.

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5 HUMAN TAPHONOMY AND GRAVE DISTURBANCE

5.1 INTRODUCTION

In order to try to understand the burial context in its entirety, it is essential to reconstruct as much as possible the events since the time of death, to sort out the various processes, how these processes work, and what effects they can have on the human remains. Grave disturbance resulting from human activity, usually in the form of grave robbing or looting, is a universal occurrence crossing chronological, geographical, and cultural boundaries. Examination of this phenomenon as a taphonomic process, however, is generally lacking in archaeological literature. Cultural processes such as these should be considered analogous to faunal or other environmental disturbances because they too can have an effect on the burial.

For the purposes of this research, I will discuss four main causes of grave disturbance by humans that either directly or indirectly influence the condition of the human remains. First, it is important to distinguish the concept of grave looting or robbing from other human disturbances. Looting is a form of human disturbance characterized by the removal or theft of something of value, such as bones or grave goods, from the grave. Currently, most grave disturbance occurs in this form due to the expanding market for artifacts through time, despite the fact it is illegal in many regions. This form of looting is a method for achieving a quick source of income and/or power by transferring the item of value from the owner (in this case the deceased) to the looter.

Second, there are cases in which material is taken, bones for example, but not necessarily because they are of value in the sense of a commodity. In this case the object is not stolen for its material worth but taken for other, perhaps ritual, symbolic, or sentimental purposes by someone who has ties to the deceased individual. In this case the intent of the 'looter' is likely social rather than economic, e.g. the 'looter' may be following the established rules of a social group.

A third type is vandalism where materials may be tampered with or even destroyed but not necessarily removed. In this case, the intention is again not for economic gain but could be a manifestation of societal norms or political gain, for example, if the relationship between groups is poor, vandalism could be way of one group demonstrating power over the other.

Finally, there are cases in which graves may be opened for another mortuary, i.e. cultural, activity such as the application of fire to the burial, in which case the remains may be intentionally or unintentionally disturbed. Altering or opening the grave for any one of the above purposes may also allow further disturbance by other cultural or environmental agents.

This study examines the taphonomic effects of grave disturbance at the Late Neolithic/Early Bronze Age cemetery Khuzhir-Nuge XIV (KN XIV) in the Lake Baikal region of Siberia. Grave disturbances are very common at KN XIV and many other Late Neolithic/Bronze Age cemeteries of the Kitoi, Servovo, and Glazkovo culture groups at Cis-Baikal. The disturbances at these cemeteries have never been examined in detail.

Investigation of the burials at KN XIV is followed by experiments designed to test questions based on data collected there. The main objectives were: 1) to examine grave disturbance at KN XIV; 2) classify grave disturbance at KN XIV; 3) determine whether or not looting occurred there; and 4) develop experiments to observe the effect of looting on the body or skeletal remains, i.e. to ascertain how looting affects skeletal condition (completeness, articulation, and fragmentation). It was expected that experiments might help to clarify which items were looted at KN XIV and how skeletal condition varies depending on certain factors associated with looting. An additional goal was to provide clues with regard to when looting may have occurred. Results may also provide information concerning the looting activity itself, for example, how looting may alter the architecture of the grave.

There are 74 graves and 84 burials at KN XIV. For the purposes of this study, 'burial' refers exclusively to the individual(s) interred in the grave. 'Grave' refers to the architecture and the burial combined. 'Architecture' is a composite attribute of the grave and may include such variables as the size and shape of the gave pit, it's orientation, the number and pattern of stones placed over the burial, etc. In this case 'architecture' refers only to the placement of stones, i.e. shape of the cairn. At least 27 of the 74 graves are disturbed by humans, as demonstrated by their architectural pattern. Fifty-six of the 84 burials were disturbed by human and/or non-human agents as evidenced by the application of fire, disarticulation of elements, and absence of certain skeletal elements, especially the skull. It is important to mention that many varieties of artifacts were

recovered from both disturbed and undisturbed graves at KN XIV, which suggests that, if looting occurred, it was not done exclusively for the removal of artifacts.

5.2 GRAVE DISTURBANCE AT KHUZHIR-NUGE XIV

Previous research at KN XIV identified the various taphonomic processes involved in the resulting skeletal condition (Lieverse 1999, 2000). Lieverse's goal was to explore the relationships between completeness, articulation, and fragmentation of skeletal elements as well as a number of independent variables such as disturbance, treated in most general terms, i.e. indicating the presence or absence of disturbance. Lieverse (1999, 2000) found that skeletal completeness was significantly associated with disturbance. That is, burials that appeared disturbed were more likely to have a higher incidence of missing skeletal elements. Interestingly, it was found that disturbance was not significantly associated with fragmentation or articulation. The study presented below is a progression of this initial work and examines the relationship between skeletal condition and disturbance in more detail.

The graves at KN XIV are distinguished within the site surface as clusters of slabs of stone, usually oval in shape, ranging from 2–3 meters by 3–5 meters. The clusters were flat or slightly mounded. The average number of stones from undisturbed feature was 229. The depth of each pit ranged from 25 to 85 cm below the modern surface. The bottom of the pit was often bedrock or partially decomposing bedrock. Most of the pits were filled and/or lined vertically with stone (Figure 5.1).

Figure 5.1. Most frequent surface layer of grave architecture at Khuzhir-Nuge XIV, Grave No. 32 (small scale=100 cm, large scale=200 cm, Photo A. Weber).

Over a third of all the graves at KN XIV exhibited architectural characteristics that differ from those described above. These graves were usually found with an area of exposed sediment in the center surrounded by a circle of stones or some slight variation of that shape (Figure 5.2). This pattern of architecture resulted from human disturbance after the initial construction of the grave, as no other agent had the ability to move the rocks in this characteristic pattern. Although, the presence of bears in the KN XIV region could explain the movement of rocks, it is unlikely that bears moved rocks in such a predictable pattern.

Figure 5.2. Disturbed grave at Khuzhir-Nuge XIV, Grave No. 30 (small scale=100 cm, large scale=200 cm, Photo A. Weber).

Burials at KN XIV were usually single, with the exception of seven double and two triple burials. Most burials lay in an extended, supine position. The orientation of the body was west to east with the head at the west end. Disturbed burials included those with skeletal elements showing evidence of fire application, such as charring or heat-induced fractures; disarticulated elements; or an absence of elements, which ranged from a few bones to the absence of the entire skeleton.

Grave disturbance does not appear to have an obvious link with any other characteristics of the feature, that is there are no observable patterns of disturbance that lend immediate explanation of why, when, and how disturbance occurred. Despite this,

closer examination of each disturbed grave reveals nine patterns of disturbance. In order for a burial to be included in the examination, it must meet at least one of the following criteria: 1) the application of fire directly on skeletal elements, 2) disarticulation of skeletal elements, 3) absence of the skull (Figure 5.3), and/or 4) absence of a complete individual. Burials were divided based on these types of burial disturbance. Each of these patterns was further distinguished by whether or not the associated grave was disturbed. The resulting nine patterns are not always mutually exclusive. If, for example, a burial was both missing a skull and altered by fire that burial was classified under whichever variable most likely had the larger impact on the disturbance. Burials were classified within the following nine categories that most closely described their context:

Figure 5.3 Burial No. 82 missing skull, Khuzhir-Nuge XIV (Photo A. Weber).

1. The architecture is not disturbed, the burial is disturbed by the application of fire but skeletal elements are in articulation, n=8 (Burial Nos. 9, 25, 29, 34, 37.2, 37.2, 38, and 54).
2. The architecture is not disturbed, the burial is disturbed by the application of fire and skeletal elements are disarticulated, n=3 (Burial Nos. 41, 43, and 66).
3. The architecture is not disturbed, the burial is disturbed as revealed by disarticulated skeletal elements, n=16 (Burial Nos. 15, 16, 17, 19, 21, 27.1, 44, 47, 50, 51, 53, 58.1, 59.2, 63, 64, and 80.2).
4. The architecture is not disturbed, the burial is disturbed as the cranium is missing, n=2 (Burial Nos. 58.2 and 77).
5. The architecture is disturbed, the burial is disturbed by the application of fire, but skeletal elements are in articulation overall, n=1 (Burial No. 24).
6. The architecture is disturbed, the burial is disturbed by the application of fire and skeletal elements are disarticulated, n= 6 (Burial Nos. 28, 52, 57.1, 57.2, 62.1, 62.2).
7. The architecture is disturbed, the burial is disturbed as revealed by disarticulated skeletal elements, n=4 (Burial Nos. 22, 31, 70, 72).
8. The architecture is disturbed, the burial is disturbed as the cranium is missing, n=15 (Burial Nos. 61, 71, 73, 74, 75, 76, 78, 79, 81, 82, 83, 84, 85, 86, and 87).
9. The architecture is disturbed, the burial is disturbed as it is completely missing, n=1 (Burial No. 30).

Among the first four patterns (Nos. 1 through 4), the burial is disturbed despite the fact that the architecture shows no obvious signs of disturbance. It can be suggested that people dismantled and then carefully rebuilt the architecture of the grave after the application of fire and perhaps after looting of the skull. However, it is doubtful that graves were opened and skeletal elements were disarticulated and then the architecture was reconstructed. Disturbance in these graves may be the result of the application of fire by humans (though if burials were burned in the flesh this would have to occur relatively soon after death, see Chapter 2), movement of bones by rodents or other animals, or other natural processes. This is especially likely in cases of children's burials where natural taphonomic processes have a greater influence on the bone (Morton and Lord 2002). However, looting is a possibility among the two burials (Nos. 58.2 and 77) in Pattern No. 4 in which the cranium is missing, as this pattern likely did not result from fire, animals, or other natural processes.

In Patterns No. 5 through 9, both the architecture and the burial have been disturbed. The variability in patterns reveals that there does not appear to be one cause of burial disturbance but rather that disturbance may be the result of many processes, cultural and natural. In Patterns No. 5 (Grave No. 24) and 6 (Grave Nos. 28, 52, 57.1, 57.2, 62.1, 62.2) it is possible that the grave was only opened for the application of fire. In some cases, the act of grave opening and/or application of fire to the remains disturbed the burials, while in other cases it did not. Though, it is not clear why this is the case. Disarticulation in Pattern No. 7 (Grave Nos. 22, 31, 70, 72) could be caused by natural

factors, but this does not explain why the architecture is also disturbed. Pattern No. 8 (Grave Nos. 61, 71, 73–76, 78, 79, 81–87), in which the skull is missing, was found among many graves. The skull was likely taken some time after the individual was buried, as the architecture is disturbed and there is a space for the head in each grave indicating that the head was once there. In all of these patterns (Nos. 5 through 9) the disturbed architecture is the evidence of possible looting, though in Patterns 8 and 9, where the feature is disturbed and the skull or entire skeleton is missing, looting is even more convincing as individuals were probably not buried without the skull when there is space to compensate the skull. Neither was a grave likely constructed without an entire individual. Patterns 4, 8, and 9 lend support to the possibility that looting for skeletal elements occurred at KN XIV.

Once the burial disturbances have been identified by patterns, the effects on each must be more clearly determined by examining each individual skeletal element (or groups of elements in the case of ribs, vertebrae, pelvis, hand, and foot bones), establishing the presence and absence of elements in disturbed burials compared to undisturbed burials following the approach developed by Lieverse (1999).

Among disturbed burials, the percentage of absent elements increases steadily from the inferior to superior region of the skeleton. That is, cranial elements are the most frequently absent. When elements are combined into groups of the appendicular region, axial region, and the skull, those of the appendicular region show a 3% greater absence among disturbed graves than the undisturbed (Figure 5.4). The axial skeleton shows an

18% greater absence (Figure 5.5). The skull shows a 30% greater absence (Figure 5.6). Therefore, it is mainly completeness of the skull and upper body that is affected by disturbance.

Figure 5.4 Percentage of present and absent skeletal elements of the appendicular region from both disturbed and undisturbed burials, Khuzhir-Nuge XIV.

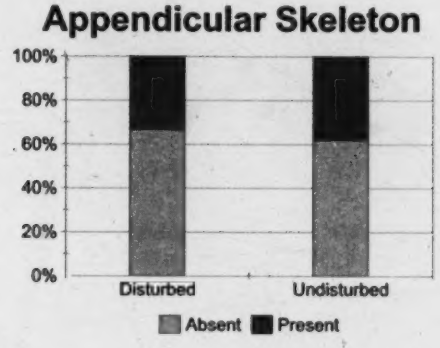


Figure 5.5 Percentage of present and absent skeletal elements of the axial region from both disturbed and undisturbed burials, Khuzhir-Nuge XIV.

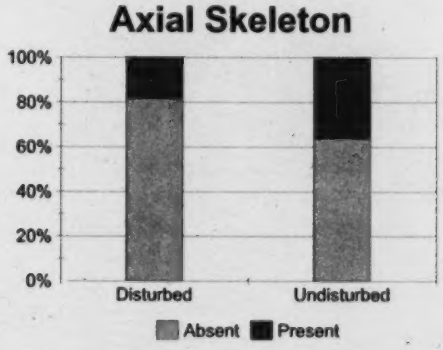
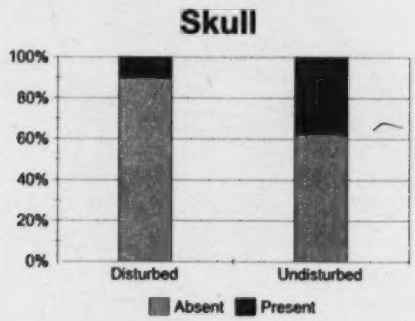


Figure 5.6 Percentage of present and absent skeletal elements of the skull from both disturbed and undisturbed burials, Khuzhir-Nuge XIV.



5.3 METHODS OF THE EXPERIMENTAL APPROACH

Five experiments were developed to test the potential influence that grave robbing could have on skeletal condition (completeness, articulation, and fragmentation). Experiments were conducted at the Ellerslie Biological Field Station in Edmonton, Alberta. The area, a gently rolling morainal plain with fine-textured glaciolacustrine sediments, provided a large natural setting outside of the city. The site lays approximately 53°N latitude and 113°W longitude with an elevation of 686 meters above sea level. The average annual temperature range is approximately −14.1°C to 17.3°C, with mean monthly temperatures below freezing for 5 months of the year. Average annual precipitation is 450 mm (http://www.worldclimate.com).

Domestic pigs (*Sus scrofa*) were used as human analogues in the experiments. The use of domestic pigs in taphonomy, decomposition, and forensic entomology experiments is

well established as an adequate comparative model for humans (Anderson and Cervenka 2002, Anderson and VanLaerhoven 1996 and 1999, Dillon 1997, France et al. 1992 and 1997, Haskell et al. 1997, Hewadikaram and Goff 1991, Janaway 1996, Komar 1999, Morton and Lord 2002, Payne and King 1968, Schoenly et al. 1991, Shean et al. 1993, Vance et al. 1995). Six pigs weighing between 45–50 kg were supplied by an Edmonton area animal processing plant and were received no later than 48 hours after death, and therefore were still considered "fresh" at the time of the experiments in the context of the mock burials.

Five pits (Nos. 10–14 of the total 22 experimental burials) were dug on June 5, 2002. A critical component of the looting experiments was the reconstruction of graves similar to the graves at KN XIV. Dimensions of the pit (214 cm in length, 68 cm in width, and 40 cm in depth) were based on KN XIV averages of all pits. Pits were lined with stone and large pieces of gravel (approximately 5–10 cm in diameter) were placed on the pit floor to simulate bedrock. Pigs were placed in the pit in an extended supine position, with a west to east orientation. A solid oval cairn was built over the top of the pit. The only feature that was notably different from the KN XIV burials was the number of stones used in the construction of the cairn, which was reduced due to cost and availability. Approximately 30 large stones ranging in size from 5 cm by 20–55 cm by 50–100 cm were used, as opposed to the mean used in graves at KN XIV, 229 stones of all sizes. Though, the number of stones used in the experiments was considerably different from KN XIV, the weight of all the stones taken together was likely closer as

the stones used in the experiment were much larger. Additionally, the majority of stones used at KN XIV may have been larger and fewer when graves were constructed and subsequently broke through time.

Volunteers were asked to loot graves at different time intervals after the initial burial: two graves after 2 weeks and three graves after 5 weeks. This period of time between burial and the looting activity was chosen in order to test the effect of looting at differing stages of body decomposition. After 2 weeks, the body should still be at an early stage of decomposition, while after 5 weeks it was projected to be closer to skeletonization.

The volunteers were instructed to take various objects including a jacket, artifacts, and the skull from each grave at each of the time intervals. The jacket was included in the experiments based on the suggestion that the clothing of the upper body was considered something of value at KN XIV, which might explain the pattern of the upper body with disarticulated or missing skeletal elements while the lower body remained relatively intact. Volunteers were asked to loot artifacts because despite the fact that many artifacts were in disturbed graves, certain artifacts still may have been taken from the graves. Finally, the removal of the skull was included as part of the experiment based on the many cases of missing skulls among KN XIV burials.

Other variables observed included the number of volunteers, i.e. one volunteer versus two, and the time required to complete the looting activity. Whether or not looting requires a relatively short or long time could play a role in understanding of the activity.

Immediately following the looting experiments and again at approximately 2 months after the initial burial, skeletal and dental inventory forms were used to record completeness, articulation, and fragmentation. Decomposition stages were recorded using Galloway et al.'s (1989) stages of decomposition. All of the burials were also photographed at the time of burial, and during and after the experiments. The bodies were left in the open grave pits after the looting experiments for future observations.

Burials No. 10 and 11 were looted approximately 2 weeks after burial (on June 22, 2002) for a jacket and artifacts respectively. Burials No. 12 and 13 were looted approximately 5 weeks after burial (on July 14, 2002) for a jacket and artifacts respectively. Burial No. 14 was looted for the skull approximately 5 weeks after burial.

5.4 RESULTS

5.4.1 BURIAL NUMBER 10

Two weeks after burial, two volunteers dismantled the feature by removing stones one by one from the grave. Volunteers took the jacket off of the pig within 3 minutes from starting the looting experiment. After the removal of the jacket, which was still completely intact, the entire body of the pig flipped over so that the body went from original supine position to lying on its left side. The head, originally in the west end and facing west, was now in the southeast corner of the pit facing east, so that the entire orientation of the pig was changed. At this time, the pig was in an early stage of

decomposition, that is, displaying a pink-white appearance with skin slippage and some hair loss with very little mummified tissue.

Approximately 3 weeks after the original burial (i.e., one week after looting), the body was further disturbed by scavengers, probably by local birds, likely black-billed magpies (*Pica pica*), who have often been seen in the vicinity and who left droppings on the stones around the pit. Dogs or coyotes, which also left scat nearby, could have caused the additional disturbance as well. The scavengers moved skeletal elements within and outside of the pit and took the skull from the pit to an unknown location.

5.4.2 BURIAL NUMBER 11

At 2 weeks after burial, two volunteers were instructed to take artifacts from the grave, but the volunteers did not know what kinds of objects were deposited within the grave. This experiment simulates looting of prehistoric graves by people who didn't know whether the objects they were looking for were there or not or where they would be located within the grave. They took some, but not all artifacts within 6 minutes from the start of the looting experiment, including a small bag with artifacts inside, one arrowhead, a spoon, and a necklace. This pig was also at an early stage of decomposition, though slightly more advanced than Burial No. 10. This time, the pig was not disturbed or moved in the looting activity. However, it was later scavenged at approximately the same time as Burial No. 10, approximately 3 weeks after the original burial. A feather

and dog and/or coyote scat was left near the pit. Bones were scattered inside the pit, transported over 4 m from the pit, and again the skull was missing.

5.4.3 BURIAL NUMBER 12

Looting of Burial No. 12, at 5 weeks after burial, took approximately 7 minutes to complete but this time there was only one volunteer. The jacket was nearly fully decomposed with only the seams remaining. The volunteer removed the seams but the pig was not affected in the removal. The pig was skeletonized, that is bones with desiccated tissue covering less than one half of the skeleton. Dog or coyote scat was seen on the cairn just prior to the looting experiment. Again the skull and mandible were later scavenged and other skeletal elements moved within the pit.

5.4.4 BURIAL NUMBER 13

At 5 weeks after burial, one volunteer looted artifacts within 8 minutes from the start of the looting experiment. These included a bead necklace, a spoon, two arrowheads, one disc ornament, and a bag with artifacts inside. The body was skeletonized, in an extended, supine position with the legs splayed. However, this time the body was somewhat disturbed in the removal of artifacts. The left scapula and arm were lifted and shifted slightly when the necklace was removed. Otherwise, the body remained in articulation. Two days after looting, the skull and both the entire legs, which were exposed during the looting experiment, were missing.

5.4.5 BURIAL NUMBER 14

The volunteer looted the cranium of Burial No. 14 in this experiment at 5 weeks after burial. It was easily removed since all of the bone was skeletonized. The volunteer did not need to remove stones covering lower body, as the skull was exposed by moving only stones at the west end above the skull and upper body. There was no movement of the skeleton during the experiment other than cranium and mandible, though the mandible was not taken out simply because it was unattached to the cranium. Approximately 1 month after the initial burial, the mandible was moved within the pit. The dentition, which was once facing up, was now facing down, and the mandible was fragmented.

On August 15, 2002, all bones were excavated and inventoried thus completing the five looting experiments.

5.5 DISCUSSION

5.5.1 COMPLETENESS, ARTICULATION, AND FRAGMENTATION

The research of human taphonomic variables conducted by Lieverse (1999, 2000) already documented a significant association between disturbance and skeletal completeness at KNXIV, though no correlation with fragmentation or disarticulation was found. The experiments carried out within this study also support the idea that looting can impact completeness, obviously when it is the skeletal elements themselves that are being looted (e.g. the cranium), but also if graves are left open or semi-open after looting. The burial is then susceptible to additional taphonomic processes, e.g. animal scavenging.

In all of the experiments (excluding the one in which the cranium was the looted object), the cranium was removed and transported by scavengers, sometimes long distances of over 25 m. It is possible that this is what was happening at KN XIV. Graves may initially have been opened to take items out (though aside from the skull, we may never know what these items were) or for other purposes such as the application of fire, and it was only after this activity that the individual itself was further disturbed by scavengers.

Looting had a direct influence on articulation of one of the experimental burials and indirectly on all burials only after scavenging. Incidentally, body position and orientation can also be altered through the looting process as was shown in Burial No. 10.

Finally, fragmentation was minimal and occurred only on the mandible of Burial No. 14 after the looting act as a result of animal disturbance.

The following conclusions can be drawn from the experiments with regard to the activity of looting itself. First, unless graves were reconstructed in the past, possibly by the looters themselves, looting will permanently alter the feature in a recognizable pattern. The shape of the cairn in the experimental graves changed from a solid oval to a large open oval similar to that seen today at KN XIV, except in the final experiment (Grave No. 14) where the entire east end of the pit remained intact. The length of the stone arrangements changed from the average of 214 cm (approximately the same length as the pit) to a range of 380–688 cm and width from an average of 68 cm (approximately the same width as the pit) to a range of 260–400 cm. For comparison, the dimensions of one of the disturbed features at KN XIV, Grave No. 30, were 450 cm in length and 350

cm in width as opposed to undisturbed which average 214 cm in length and 68 cm in width. There were also approximately one-third more stones after the experiments than were used in the initial construction, indicating that they were broken some time after burial, likely during construction of the cairn and/or the looting activity.

Second, it is possible for only one or two people to loot a grave despite the heavy weight and large size of rocks that may have been used and it does not take long to dismantle this type of feature: less than 10 minutes was required in all five experiments despite the type of object being looted. It would take even less time if only one specific part of the grave was targeted as in Burial No. 14. The process would take approximately seven times as long (slightly over 1 hour) if the number of stones equaled that observed at KN XIV (assuming 10 minutes for every 30 stones) and if every stone was removed.

It is difficult to assess exactly when looting could have occurred at KN XIV. In cases where the skulls were taken, assuming similar rates of decomposition as in the experiments, it could have occurred at least 2 weeks after burial. Prior to 2 weeks, the skulls in the experiments were still firmly attached to the body. At KN XIV, there aren't any cut marks or any indication of decapitation suggesting that skull removal occurred prior to an advanced or skeletonized stage of decomposition. However, at KN XIV cut marks may be difficult to see given the relatively poor preservation of the remains. After 5 weeks, removal of the skull was feasible in all the experiments. Decomposition is a function of many factors: season and corresponding temperature, clothing, burial depth, etc. (see Chapter 6). One should use caution when making direct comparisons between

rate of decomposition of the experimental burials in Alberta and burials at KN XIV in Siberia as the variability in taphonomic factors may be quite large between the two locations. However, because the skull is one of the first elements to disarticulate fully from the rest of the body (Haglund 1989), there is a strong probability that natural disarticulation of the skull occurred relatively early at least before the rest of the skeleton.

The differing types of grave disturbance will affect completeness, fragmentation, and articulation differently. The impact of the application of fire to a burial will vary depending on whether or not there is also stoking or stirring of the fire. While a fire that has not been restoked or stirred may not disturb the burial remains, a fire that was stoked or stirred may. Stoking a fire while tending may result in further fragmentation of the hot, brittle, heat-fractured bone. Stirring of the fire may have this same result in addition to disarticulation of the heat-fractured bone, with the degree of disarticulation increasing with the amount of stirring. There are eight individuals (Burial Nos. 28, 41, 43, 52, 57.1, 57.2, 62.1, 62.2) of the 20 charred at KN XIV where disturbance of the fire or a portion of the fire may have resulted in their disarticulation (Chapter 2).

Similarly, opportunistic or targeted looting for objects will alter the skeletal condition differently depending on whether or not the artifacts are known prior to looting, the artifacts are simple or complex, and the objects are specific skeletal elements. If the looter is aware of the object prior to opening the grave the disturbance may have less of an impact as opposed to the looter simply looking for unknown objects in the grave. Similarly, if the looter has targeted the grave for one simple artifact (e.g. a specific tool)

they are likely to have less of an impact of fragmentation or articulation of remains than if they are targeting several artifacts or more complex ones (e.g., clothing, entire tool kits, or composite artifacts such as necklaces).

Finally, the application of fire may have occurred simultaneously with targeted looting. A grave could have been opened for the looting of objects and then a fire constructed over the burial for symbolic reasons, for example to purify the burial place with fire (Derevyanko 1994), or practical reasons, such as ridding the individual of soft tissue and thus rendering less desirable to animals.

5.6 CONCLUSIONS

Does the activity of looting alter skeletal condition, i.e., can it be considered an important cultural taphonomic process? Both the skeletal material from KN XIV and experimental observations clearly demonstrate that looting influences completeness, disarticulation, and fragmentation in a significant manner. It does so both directly and indirectly.

Further research on the topic of grave disturbance should focus on the various other explanations for the patterns of disturbance beyond looting. In Chapter 2 of this dissertation, an examination of the mortuary use of fire and its effects on skeletal condition were discussed in detail. The application of fire to a burial influences completeness, articulation, and fragmentation, and may explain in part the disturbance observed in Patterns No. 1 and 5, in which the feature may or may not be disturbed but

the undisturbed burial shows evidence of fire. Stirring or restoking the fire is a plausible explanation for disarticulation of skeletal elements, particularly in Pattern No. 2, in which the feature is disturbed, there is evidence of fire, and the burial is disarticulated.

Taphonomic agents other than humans also need to be considered closely. Natural factors, such as animals, could help to explain many of the disturbance patterns. Studies should be aimed at determining the animals present at KN XIV through time, as well as the kinds of evidence that exist for the presence of these animals in the graves (e.g. krotovinas).

Finally, a larger examination of grave disturbance is currently underway as a Master's thesis topic at the University of Alberta by Cameron Robertson. It is possible that new data and results from this thesis will provide more insights at KN XIV.

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6. A REPORT OF DECOMPOSITION RATES OF A SPECIAL BURIAL TYPE IN EDMONTON, ALBERTA FROM AN EXPERIMENTAL FIELD STUDY[1]

6.1 INTRODUCTION

It has often been stated that the difficulty involved in estimating time since death in forensic investigations is in part due to the lack of a wide range of regional studies on the rate of decomposition of the human body (Mann et al. 1990, Rodriguez et al. 1985, Sorg and Haglund 2002). Studies of this nature that do exist are mainly limited to regions in the southern United States and often focus on bodies placed above ground rather than below. However, there is a high degree of variability between both the regional environments and immediate contexts or microenvironments of the deceased. This study focuses on decomposition of a variety of experimental burials in central Alberta and may help narrow the gap of knowledge that exists in time since death estimations particularly in this region.

6.2 METHODS

A replicate cemetery site was constructed in Edmonton, Alberta as part of a large project aimed at understanding the role of certain taphonomic factors, mainly cultural, at a Late Neolithic/Early Bronze Age cemetery in the Lake Baikal region of Siberia. As the experiments progressed, it became apparent that the information gained also could be of forensic relevance and contribute unique data regarding decomposition rates. The experimental site is located at the Ellerslie Biological Field Station (EBFS) in Edmonton.

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[1] A version of this chapter has been published. Weitzel, MA. 2005. Journal of Forensic Sciences. 50(3).

The area, a gently rolling morainal plain with fine-textured glaciolacustrine sediments, provided a large natural setting outside of the city. The site lays approximately 53°N latitude and 113°W longitude with an elevation of 686 meters above sea level. The average annual temperature range is approximately –14.1°C to 17.3°C, with mean monthly temperatures below freezing for 5 months of the year. Average annual precipitation is 450 mm (http://www.worldclimate.com).

In total, 21 domestic pigs (*Sus scrofa*) were buried in 21 pits (i.e., burials were single) at the site during the months of May, June, and August 2002. The use of domestic pigs as models for humans in taphonomy, decomposition, and forensic entomology experiments is well established as an adequate comparative model. Pigs were donated by an Edmonton area animal processing plant and had not been deceased for more than 48 hours prior to burial. During this time the pigs laid on the cement floor inside the building. Therefore, bodies were still considered fresh at the time of burial.

Burial No. 1 was created as the control burial. All other graves and corresponding burials were made to the same specifications as No. 1 with the exception of one variable, which was altered (and two variables in Nos. 6, 8, 9, and 21). Due to the large number of experimental burials used in this investigation and limited time frame for conducting the experiments, replications of each burial were not constructed. Had fewer burial treatments been examined, then replicated studies would have been conducted for each. However, replication experiments are a recommendation for any future research.

The unclothed pig used in Burial no. 1 weighed approximately 50 kg. It was placed in a pit in an extended position and as close to supine as possible, though leaning slightly toward one side. Maximum rigor mortis had already occurred; joints and muscles of all the pigs were relaxed at the time of burial. Pit dimensions, 68 cm wide by 214 cm long pit and 40 cm deep, were based on averages calculated at the cemetery in Siberia. Because the graves were initially constructed to help understand activity that occurred at an archaeological site, the construction conformed to that site as much as possible. Therefore, the grave for Burial No. 1 was built with approximately 20–30 large, flat paving stones placed directly over the top of the burial forming a cairn over the body.

Burial No. 2 differed from No. 1 only by the addition of clothing. The pig was dressed in a fur coat covering the torso region and a pair of leather moccasins covering the back feet. Burial No. 3 was covered with sediment rather than stone. Burial No. 4 was covered with 30–40 more stones than No. 1 and Burial No. 5 was covered with 19 fewer stones than No. 1. Burial No. 6 was covered in 20–30 more stones and was buried 25 cm deeper than No. 1; Burial No. 7 was 20 cm closer to the surface. Burial No. 8 was covered in a large stone cairn built suspended across a large 125 x 260 cm pit. The cairn did not come into contact with the pig as it did in all other burials but lay approximately 50 cm above the pig. Burial No. 9 was a small pig of approximately 25 kg in a relatively small pit of 40 x 95 cm. Burials No. 10–14 were used in a grave robbing experiment. Numbers 10 and 12 were dressed in leather jackets and Nos. 11 and 13 were buried with various artifacts inside the pit. Number 14 matched No.1 with no variation. Burials No.

15 through 20 were partially cremated. A fire using 5–11 kilograms of pine or birch was built over the thoracic region and allowed to burn for approximately 2.5 to 4 hours. Burial No. 19 was wrapped in birch bark prior to cremation and No. 20 was covered in red ochre. Burial No. 21, though not exposed to fire, was also covered in red ochre and the grave was built with 30–40 more stones than No.1. Results from the looted, cremated, and ochre-treated burials will be discussed in other papers (Weitzel, in press).

Grave pits were placed 3 meters or more apart. Burials were placed west to east, with the head to the west, in an extended, supine position in as much as possible though sometimes resting on their side (Nos. 15, 16, 19, 20, and 21). Pigs were deposited at different times of the year, nine in May, five in June, and seven in August of 2002. Weather data consisting of air temperature, relative humidity, precipitation, wind direction and speed, solar radiation, and sediment temperature were recorded hourly and averaged daily for the duration of the project. General data on above ground insect activity were also recorded as frequently as possible (usually two to three days a week). Insects were not collected, as insect research has already been reported at this site (Anderson et al. 2002). Sediment data that had previously been collected at the site were also made available. Sediments in the research area consisted of Eluviated Black Chernozemic soils (Crown et al. 1978).

Graves were opened at various times after burial; two at 2 weeks (Burials No. 10 and 11), three at approximately 5 weeks (Burials No. 12 –14), nine at 3 months (Burials No. 1–9), seven at 1 year (Burials No. 15–21), and nine were reopened at 15 months (Burials

No. 1 – 9). The reason the graves were opened at these particular periods of time related to the individual studies that each was initially a part of (e.g. studies of Burials No. 15–21 examined the mortuary use of fire, Burials No. 20–21 red ochre, Burials No. 1–9 grave architecture, and Burials No. 10–14 grave disturbance). Observations were recorded and burials were photographed but the bodies were not disturbed. Instead they were reburied for future observations with the exception of Nos. 10–14, which were dismantled after the looting experiments. An inventory of bone and teeth was taken only when visible without being too invasive. Decomposition stages were recorded using Galloway, et al.'s (1989) stages of decomposition (Table 6.1).

Table 6.1. Categories and stages of decomposition (Galloway et al 1989).

A. Fresh
    1. Fresh, no discoloration or insect activity
    2. Fresh burned
B. Early decomposition
    1. Pink-white appearance with skin slippage and some hair loss
    2. Gray to green discoloration; some flesh relatively fresh
    3. Discoloration to brownish shades particularly at fingers, nose, and ears; some flesh still relatively fresh
    4. Bloating with green discoloration
    5. Post bloating following rupture of the abdominal gases, with discoloration going from green to dark
    6. Brown to black discoloration of arms and legs; skin having leathery appearance
C. Advanced decomposition
    1. Decomposition of tissues producing sagging of the flesh; caving in of the abdominal cavity, often accompanied by extensive maggot activity
    2. Moist decomposition in which there is bone exposure
    3. Mummification with some retention of internal structures
    4. Mummification of outer tissues only with internal organs lost through autolysis or insect activity
    5. Mummification with bone exposure of less than one half the skeleton
    6. Adipocere development
D. Skeletonization
    1. Bones with greasy substances and decomposed tissue, sometimes with body fluids still present
    2. Bones with dessicated tissue or mummified tissue covering less than one half the skeleton
    3. Bones largely dry, but still retaining some grease
    4. Dry bone
E. Extreme decomposition
    1. Skeletonization with bleaching
    2. Skeletonization with exfoliation
    3. Skeletonization with metaphyseal loss, with long bones and cancellous exposure of the vertebrae

6.3 RESULTS

6.3.1 2 WEEKS AFTER BURIAL

Characteristics of early decomposition at the 2-week interval correlate well with that reported by Galloway, et al. (1989). Burials No. 10 and 11 showed the least amount of decomposition of all experiments (stage B or early decomposition) as would be expected only 2 weeks after burial (Table 6.2). Burial No. 10 (stage B, 1–3) exhibited some fly larvae (maggot) activity at the nasal region upon initial exposure; maggots then dispersed after approximately 30 minutes. There were numerous flies concentrated around the cavities. The ears and nose were black and desiccated and there were patches of skin slippage on the torso region. Otherwise the pig appeared to be relatively fresh. Burial No. 11 (Stage B, 5–6) displayed more maggot activity than No. 10 but again the masses dispersed after approximately 30 minutes. There was intense chemical activity resulting from putrefaction, or the anaerobic stage of decomposition, in the form of brown liquid foam over the thoracic region but this also disappeared after about 30 minutes following exposure. There was some skin slippage throughout the body. The head and upper thoracic region showed spots of black desiccated tissue. The left front leg was the most affected by insects with only ligaments and the far posterior tissue remaining, which was in direct contact with the surface of the pit.

Table 6.2. Burial and excavation dates and stages of decomposition.

Grave no.	Wt. of pig (kg)	Pit dimensions (cm)	Depth (cm)	No. of stones	Cloth-ing	Fire	Burial date	1st excavation date	Stage of decomp-osition	2nd excavation date	Stage of decomp-osition
1	45 - 50	68 x 214	40	20 - 30	No	No	5/31/2002	8/29/2002	C 5	8/26/2003	C 5
2	45 - 50	68 x 214	40	20 - 30	Yes	No	5/31/2002	8/29/2002	C 4 - 5	8/26/2003	C 5
3	45 - 50	68 x 214	40	0 (sediment)	No	No	5/31/2002	8/29/2002	C 2 - 3	8/26/2003	n/a (scavenged)
4	45 - 50	68 x 214	40	60	No	No	5/31/2002	8/29/2002	C 3 - 4	8/26/2003	C 4
5	45 - 50	68 x 214	40	20 - 30	No	No	5/31/2002	8/29/2002	C 5	8/28/2003	C 5
6	45 - 50	68 x 214	65	50	No	No	5/24/2002	8/28/2002	D 2 - 3	8/28/2003	D 2 - 3
7	45 - 50	68 x 214	20	20 - 30	No	No	5/24/2002	8/28/2002	C 4 - 5	8/28/2003	C 5
8	45 - 50	125 x 260	65	75 (suspended)	No	No	5/24/2002	8/28/2002	D 1	8/28/2003	D 2
9	25	40 x 95	50	20 - 30	No	No	5/24/2002	8/28/2002	D 1	8/26/2003	D 2
10	45 - 50	68 x 214	40	20 - 30	Yes	No	6/7/2002	6/22/2002	B 1 - 3	n/a	n/a
11	45 - 50	68 x 214	40	20 - 30	No	No	6/7/2002	6/22/2002	B 5 - 6	n/a	n/a
12	45 - 50	68 x 214	40	20 - 30	Yes	No	6/7/2002	7/14/2002	D 2 - 3	n/a	n/a
13	45 - 50	68 x 214	40	20 - 30	No	No	6/7/2002	7/14/2002	D 2 - 3	n/a	n/a
14	45 - 50	68 x 214	40	20 - 30	No	No	6/7/2002	7/14/2002	D 4	n/a	n/a
15	45 - 50	68 x 214	40	20 - 30	No	Yes (2.5 Hr)	8/18/2002	8/25/2003	D 2 - 3	n/a	n/a
16	45 - 50	68 x 214	40	20 - 30	No	Yes (3.5-4 Hr)	8/18/2002	8/25/2003	C 5	n/a	n/a
17	45 - 50	68 x 214	40	20 - 30	No	Yes (2.5 Hr)	8/18/2002	8/25/2003	D 2	n/a	n/a
18	45 - 50	68 x 214	40	20 - 30	No	Yes (2.5 Hr)	8/18/2002	8/26/2003	D 2	n/a	n/a
19	45 - 50	68 x 214	40	20 - 30	No	Yes (2.5 Hr)	8/18/2002	8/26/2003	D 2 - 3	n/a	n/a
20	45 - 50	68 x 214	40	20 - 30	No	Yes (3.5-4 Hr)	8/18/2002	8/26/2003	C 5	n/a	n/a
21	45 - 50	68 x 214	40	50 - 70	No	No	8/16/2002	8/25/2003	D 3	n/a	n/a

During this 2–week interval in June the average air temperature reached a high of 30.3°C on June 22, 2002 and low of 14.0°C, also on June 22, 2002. The average for this day was 22.0°C (Table 6.3 and 6.4). This was the same day the pigs were excavated. Average solar radiation was also high on this day (1.5 kj/hr); the maximum during the 2 weeks was 1.6 kj/hr on June 12, 2002. The average air temperature of the entire 2 weeks was 16.1°C. Sediment temperatures were also relatively high averaging 14.0°C at 5 cm deep and 11.1°C at 15 cm deep.

Table 6.3. Summarized weather data for duration of experiments.

Weather Data	2 weeks	5 weeks	3 months	12 months	15 months
Daily Maximum Air Temperature Mean (Celsius)	23.17	25.39	23.43	14.77	17.75
Daily Minimum Air Temperature Mean(Celsius)	7.2	9.42	15.89	---	---
Mean Air Temperature (Celsius)	16.11	18.16	7.64	5.78	5.01
Daily Maximum Relative Humidity Mean (%)	86.96	87.99	---	---	---
Daily Minimum Relative Humidity Mean (%)	28.36	28.3	16.62	---	---
Mean Relative Humidity (%)	52.89	54.79	92.64	98.01	---
Total Precipitation (mm)	4	30.2	---	---	---
Mean Total Precipitation (mm)	0.25	0.82	---	---	---
Mean Wind Speed (Km/Hr)	9.98	10.99	47.13	---	30.4
Mean Solar Radiation (Kj/m)	1.25	1.25	---	---	2.43
Daily Maximum SedimentTemperature Mean at 5cm (Celsius)	18.88	20.11	---	11.82	11.82
Daily Minimum Sediment Temperature Mean at 5cm (Celsius)	9.42	11.72	---	8.39	8.39
Mean Sediment Temperature at 5 cm (Celsius)	14.01	15.72	20.16	7.47	11.61
Daily Maximum Sediment Temperature Mean at 15cm (Celsius)	14.35	15.45	15.21	8.25	10.39
Daily Minimum Sediment Temperature Mean at 15cm (Celsius)	9.34	11.8	11.04	6.19	7.86
Mean Sediment Temperature at 15 cm (Celsius)	11.10	13.68	16.21	8.14	10.13

Due to a power failure, data between November 12 and December 1, 2002 were not included. Missing data resulting from erroneous weather station readings are represented by dashes.

Table 6.4. Daily ambient and soil temperature data at the 2-week interval.

Year	Month	Day	Daily Maximum Air Temp (°C)	Daily Minimum Air Temp (°C)	Average Air Temp (°C)	Daily Maximum Sedd Temp 5cm (°C)	Daily Minimum Sed. Temp 5cm (°C)	Average Sed. Temp 5cm (°C)	Daily Maximum Sed. Temp 15cm (°C)	Daily Minimum Sed. Temp 15cm (°C)	Average Sed. Temp 15cm (°C)
2002	6	7	18	0.6	11.1	16.3	7.1	11.6	12.9	5.3	10.2
2002	6	8	18.8	4.2	12.4	16.3	6.3	11.8	12.9	5.7	10.2
2002	6	9	21.1	8.6	14.3	15.6	8.4	12.4	12.7	8.2	10.7
2002	6	10	21.8	6.9	15.2	17.2	5.8	11.7	14.5	3.2	10.4
2002	6	11	21.8	7.8	15.5	16.9	6.7	12.4	13.3	7.4	10.7
2002	6	12	---	4	17.8	23.9	8.2	13.6	17.7	7	11.2
2002	6	13	27.1	7.8	19.2	17.2	10	14	13.1	10.3	11.9
2002	6	14	26	10.9	19.3	20.1	11.4	15.3	14.3	11	12.6
2002	6	15	29.5	8.6	20.5	21.3	11.1	15.9	15	11.2	13.1
2002	6	16	27.3	8.8	18.9	21.8	12	16.6	15.5	12	13.8
2002	6	17	18.7	8.4	12.6	18.3	12.4	15.4	14.8	12.4	13.6
2002	6	18	14.6	6.5	9.8	14.7	10.5	12.9	13.6	11.6	12.2
2002	6	19	20.8	3.3	13.4	18.8	8.5	13.4	13.7	9.8	11.7
2002	6	20	24.2	4.7	16.4	20.7	9.7	14.8	14.6	10.6	12.6
2002	6	21	27.5	9.4	19.3	21.9	11.1	16.2	15.6	11.5	13.5
2002	6	22	30.3	8.6	22	21.1	11.7	16.3	15.5	12.2	13.9

6.3.2 5 WEEKS AFTER BURIAL

All the burials that were examined after approximately 5 weeks (Nos. 12, 13, and 14) were at a stage of skeletonization (stage D). They were more decomposed than some other burials that were left for longer periods (three months to 15 months). Burial No. 12 (stage D, 2–3) was dressed in a leather jacket and only the seams of the jacket remained at the time of observation. Bones were dry and stained although some ligaments remained. Skin and hair remained on the skull and ears as well as the lower feet. Burial No. 13 (stage D, 2–3) also displayed dry bones with some staining. Some mummified tissue and hair remained on both lower back legs and the skull. Burial No. 14 (stage D, 4) showed the most advanced decay of the three, with all of the bones appearing dry and relatively clean.

Air temperatures during the June and July 5-week interval reached a high of 34.7°C on July 11, 2002 and low of .6°C on June 7, 2002 (Table 6.5), a 34.1°C difference. The average air temperature for the 5 weeks (18.2°C) was the highest of all time intervals. There was more precipitation (30.2 mm) than there was at the 2-week interval (4 mm). Average sediment temperatures were 15.7°C and 13.7°C at 5 cm and 15 cm deep, respectively.

Table 6.5. Daily ambient and sediment temperature data at the 5-week interval.

Year	Month	Day	Daily Maximum Air Temp (°C)	Daily Minimum Air Temp (°C)	Average Air Temp (°C)	Daily Maximum Sed. Temp 5cm (°C)	Daily Minimum Sed. Temp 5cm (°C)	Average Sed. Temp 5cm (°C)	Daily Maximum Sed. Temp 15cm (°C)	Daily Minimum Sed. Temp 15cm (°C)	Average Sed. Temp 15cm (°C)
2002	6	7	17.95	0.603	11.07	16.32	7.13	11.6	12.9	5.301	10.18
2002	6	8	18.78	4.215	12.4	16.27	6.347	11.8	12.91	5.736	10.21
2002	6	9	21.14	8.63	14.34	15.61	8.39	12.39	12.74	8.22	10.68
2002	6	10	21.83	6.898	15.24	17.22	5.813	11.7	14.53	3.158	10.35
2002	6	11	21.84	7.81	15.54	16.89	6.665	12.4	13.29	7.41	10.65
2002	6	12	66.92	4.025	17.77	23.91	8.19	13.56	17.66	6.96	11.16
2002	6	13	27.11	7.78	19.16	17.22	10.01	14.01	13.11	10.26	11.85
2002	6	14	25.97	10.85	19.25	20.11	11.37	15.33	14.3	10.98	12.55
2002	6	15	29.53	8.6	20.48	21.32	11.1	15.87	14.96	11.24	13.08
2002	6	16	27.27	8.82	18.87	21.77	11.91	16.56	15.52	11.96	13.77
2002	6	17	18.74	8.38	12.59	18.33	12.38	15.35	14.79	12.42	13.62
2002	6	18	14.64	6.5	9.81	14.72	10.53	12.9	13.56	11.62	12.22
2002	6	19	20.8	3.52	13.41	18.79	8.45	13.37	13.69	9.82	11.72
2002	6	20	24.19	4.733	16.42	20.66	9.72	14.75	14.57	10.62	12.56
2002	6	21	27.49	9.42	19.29	21.9	11.07	16.17	15.57	11.51	13.48
2002	6	22	30.34	8.56	22.04	21.1	11.68	16.32	15.5	12.16	13.9
2002	6	23	31.46	15.23	22.84	22.43	13.65	17.68	16.42	13.11	14.67
2002	6	24	26.46	16.32	20.2	21.13	15.22	17.34	16	13.93	14.92
2002	6	25	29.2	14.5	22.08	24.08	14.25	18.72	17.47	13.73	15.45
2002	6	26	34.46	13.63	25.4	25.17	15.15	19.74	18.2	14.52	16.32
2002	6	27	32.57	15.98	23.58	24.69	16.38	19.85	18.28	15.41	16.87
2002	6	28	21.33	12.4	18.07	20.26	15.45	17.76	17.32	15.16	16.01
2002	6	29	24.14	10.61	16.09	20.09	8.49	15.15	16.07	12.41	14.28

Table 6.5. Daily ambient and soil temperature data at the 5-week interval (Con't.).

Year	Day	Month	Daily Maximum Air Temp (°C)	Daily Minimum Air Temp (°C)	Average Air Temp (°C)	Daily Maximum Sed. Temp 5cm (°C)	Daily Minimum Sed. Temp 5cm (°C)	Average Sed. Temp 5cm (°C)	Daily Maximum Sed. Temp 15cm (°C)	Daily Minimum Sed. Temp 15cm (°C)	Average Sed. Temp 15cm (°C)
2002	6	30	20.35	8.75	14.53	19.09	12.31	15.25	15.1	12.8	13.91
2002	7	4	20.99	-51.64	15.66	18.12	11.96	14.7	14.45	12.25	13.33
2002	7	5	20.39	5.749	13.55	17.22	11.3	13.96	13.98	12.11	13.11
2002	7	6	24.39	4.025	15.83	19.57	10.25	14.56	14.73	11.52	13.07
2002	7	7	28.97	6.516	20.44	19.79	11.44	15.52	15.13	12.28	13.71
2002	7	9	26.61	11.92	19.95	21.55	13.07	16.87	16.13	13.04	14.41
2002	7	10	30.95	12.29	22.82	21.55	14.17	17.67	16.56	13.99	15.25
2002	7	11	34.74	15.69	25.53	24.61	15.58	19.59	18.08	14.95	16.39
2002	7	12	34.65	18.95	26.79	25.23	16.35	20.34	18.79	15.75	17.21
2002	7	13	33.69	18.29	26.17	24.12	17	20.35	18.63	16.36	17.56
2002	7	14	24.52	13.34	20.32	21.44	16.61	19.44	18.21	16.98	17.49

6.3.3 3 MONTHS AFTER BURIAL

Burials No. 1–9 were opened after approximately 3 months. Nos. 1–5 and 7 were at an advanced stage of decomposition (stage C). Nos. 6, 8, and 9 were partially skeletonized (stage D). Burial No. 3 (stage C, 2–3) (covered in sediment) revealed the least amount of decomposition of this group. Bones of the arms, ribs, and pelvis were exposed but a large amount of pink flesh and other soft tissue still existed throughout the body. Burial No. 1 (stage C, 5) was mostly mummified with some hair remaining. There was exposure of the maxilla, mandible, right front leg bones, some upper right ribs, lumbar vertebrae, pelvic bones, and the head of the femora. Burial No. 4 (stage C, 3–4) was also mummified with some patches of hair and some bone exposure. The pig was damp in the thoracic and abdominal area. Three vertebrae, three lower ribs, and parts of the lower back leg bones of Burial No. 7 (stage C, 4–5) were exposed. There was some mold on the upper left ribs and adipocere was present throughout the center thoracic region. Rodent gnawing was observed on the right patella. Burials No. 2 (stage C, 4–5), 5 (stage C, 5), and 7 (stage C, 4–5) were almost completely mummified. At least five mice were seen within the pit of Burial No. 2 at the time it was opened and there was a nest between the two back legs.

Burial No. 6 (stage D, 2–3) was skeletonized but covered in white mold except the lower left ribs where a stone was placed directly over the bone and mold was potentially unable to grow. Burial No. 8 (stage D, 1) was mostly skeletonized with hair and skin present on the head, along the right side of the body, and the lower back legs. There was

adipocere all through the thoracic region and the bones were damp and brown. Finally, Burial No. 9 (stage D, 1) was also covered in white mold and the bones were damp. The skull retained some mummified tissue.

The highest air temperature reached during the 3-month interval was the same as the 5-week interval, i.e. 34.7°C on July 11, 2002. The low temperature was 9.3°C on June 17, 2002. The average air temperature for the three months was relatively low (7.6°C). However, wind speed (20.2 km/hr) was relatively high. Average sediment temperatures were the highest of all the time intervals, 20.2°C at 5 cm deep and 16.2°C at 15 cm deep.

6.3.4 12 MONTHS AFTER BURIAL

The only graves to be excavated at a 1-year interval were the six that were partially cremated (nos. 15–20) and the one covered in red ochre (no. 21). All were skeletonized (stage D) except two of them (nos. 16 and 20), which showed an advanced stage of decomposition (stage C). Surprisingly, these two burned for the longer durations than the skeletonized burials (3.5–4 hours as opposed to 2.5 hours). Burial No. 16 (stage C, 5) was mostly mummified particularly at the head, pelvis, and legs. Burial No. 20 (stage C, 5) was mummified at the mandible, cervical vertebrae, pelvis, front and back legs. A rodent nest was located inside the rib cage and there was some gnawing of ribs. All bones were stained red from the red ochre applied at the time of burial. Burial No. 15 (stage D, 2–3) was mostly skeletonized with some mold and dampness of bones and some mummified tissue. Two rodent nests were found within the burial, one just north of

the skull and one next to the proximal end of the right femur. Burial No. 17 (stage D, 2) was mostly skeletonized with some mummification and hair on the skull and lower front legs and mold on the ribs. Burial No. 18 (stage D, 2) was mostly skeletonized with some mummification on the head, pelvic area, and lower back legs. Some mold was present on the thoracic vertebrae. One rodent nest was found in the thoracic region. Burial No. 19 (stage D, 2–3) was more skeletonized than 17 and 18. Some dry tissue remained on the lower thoracic/abdominal area, legs, and to a lesser degree on the head. Burial No. 21 (stage D, 3) was completely skeletonized and stained red from ochre.

Air temperatures during the 1-year interval reached a high of 32.0°C on August 18, 2003. Unfortunately, due to an error in the weather station records, the low temperature was not reported. The yearly average air temperature was relatively low at 5.8°C. Average sediment temperatures at 5 cm and 15 cm deep were the lowest of all time intervals at 7.4°C and 8.1°C, respectively.

6.3.5 15 MONTHS AFTER BURIAL

The same graves that were opened at a 3-month interval were also reopened at 15 months (Nos. 1–9). These nine graves were the only graves to be opened for observation, reburied, and opened again for a second observation. Opening of graves at the 3-month interval can result in further insect colonization of remaining tissue and other additional variables such as scavenging. However, at this time all nine burials were at the same stage of decomposition that they were at after 3 months. There were only minor changes

a year later (from August 2002 to August 2003) with slightly more bone exposure. Burial No. 3 was scavenged shortly after it was opened the first time likely by dog or coyote and, as a result, could not be observed at this time. Carnivore activity reportedly appears to occur during advanced decomposition and initial mummification (Galloway et al. 1989) and since this was the only burial that was not covered in stone it was the only one affected.

Due to technical problem creating errors in the weather station records, some of the weather data from the 15–month interval was missing. Overall, averages during the 15 months appeared to be without any extreme highs or lows in all observable categories.

6.4 DISCUSSION

6.4.1 TIME SINCE DEATH

Based on the data supplied by the experiments, it appears that it takes approximately 3 to 5 weeks for pigs buried in June at a depth of 40 cm to skeletonize. It takes between 5 weeks and 3 months for those buried in May, deeper than 40 cm, to skeletonize. In a study involving 20 human cases at the Edmonton Office of the Chief Medical Examiner, Komar (1998) showed reduction to skeletal remains in less than 6 weeks in moderate summer temperatures. The depositional environments in Komar's study varied from aquatic to surface; only two of them were burials.

6.4.2 WEATHER DATA

Temperature and humidity are said to be the most important factors affecting decomposition rates, the higher the temperature and humidity the greater the rate of decomposition (Mann et al. 1990). Accordingly, the development of fly larvae is almost entirely a function of temperature.

Regardless of any changes in weather during the 2–week interval in June 2002, pigs likely would not decay beyond the early decomposition stage. This is true despite the high air and sediment temperatures on the last day of this time interval. Yet, these high temperatures and high solar radiation on June 22, 2002 do explain in part the active decay observed during excavation, in particular the presence of maggot masses and active processes of putrefaction. Subsequently, maggot masses themselves generate a great amount of heat and this also explains why decomposition and skeletonization occurred so rapidly. Blow fly larvae were able to easily access the remains either prior to burial, during burial, or both through openings in the rocks.

June and July of 2002, the 5–week interval, witnessed the highest average air temperature of all the time intervals combined accounting for the skeletonization of all three of the burials. Increased precipitation that may have seeped through the stones may have further separated the soft tissue from the bone.

Air temperatures were relatively low during the 3–month interval in May–August, 2002 but sediment temperatures were high. All of the skeletonized burials came from deeper burials (see section on Burial Depth) perhaps affected by temperatures closer to

those of the sediment matrices than those of the air. Sediment temperatures are very important in decomposition of buried bodies and agriculture station sub-sediment temperature data can usually be obtained when working with buried body cases. The remaining burials in an advanced stage of decomposition lie closer to the surface. Mummification of these burials could partially be explained by high wind speed during this time (averaging 47.1 km/hr). Wind may have traveled through the openings in the stones contributing to desiccation of tissue.

At the 1–year interval, average air and sediment temperatures were relatively low. However, summer temperatures alone were high. Skeletonization during this period probably has more to do with the influence of summer temperatures as well as the application of fire.

Finally, at the 15–month interval, temperatures and other weather data were relatively moderate. The lack of any periods of extreme highs is demonstrated by the fact that stages of decomposition did not change between the three-month interval and the 1–year interval.

Though Alberta typically features dry, cold weather in the winter, summer temperatures often match that of more southerly regions and this helps explain the relatively rapid rates of decomposition. Studies at the University of Tennessee have shown that bodies buried at 1 to 2 feet skeletonize in a few months to a year (Mann et al. 1990). The Tennesssee experimental studies also report that arid areas produce desiccated and mummified remains that show little destruction by insects under natural

conditions and retain skin anywhere from 2 to 6 years after death (Mann et al. 1990). The Edmonton weather conditions have lead to mummification similar to that seen in places known for their extreme aridity such as southern Arizona (Galloway et al. 1989).

6.4.3 INSECTS

The exact time in which eggs were deposited on the burials is unknown. It is plausible that flies had access to the pigs very soon after death at the time the pigs were at the processing plant, prior to burial. However, this is also possible for real death case scenarios in which bodies lie on a surface before they are deposited in burials. Therefore, the immediate access of flies to the body is not an artificial but rather real phenomenon. An alternative experimental approach would be to euthanize animals at night at the site in order to avoid ovipositing of blow flies who are active at night. This would ensure that fly eggs and maggots would not infest dead pigs prior to commencing the experiment, thus providing more accurate data.

6.4.4 GRAVE TYPE

Two types of graves were constructed in this investigation, a burial covered with a rock cairn and a pit filled with sediment over the burial (No. 3). The sediment-filled grave was much more susceptible to large scavengers than those covered with stone. The pig in Burial No. 3 was quickly removed by animals after observations were made at 3 months. At the time of observation the pig in the sediment-filled grave was at the same

stage of decomposition (advanced decomposition) as those covered with stone; it was only slightly less decomposed. The scavenging activity was likely prompted by the initial grave opening. In a report of insect succession on carrion by Anderson et al. (2002) at the EBFS, pigs reportedly buried 1 foot below surface were scavenged 2 days after burial. The cairn-covered grave type is a very important factor when evaluating stages of decay. The random placement of stones allows for the passage of air, precipitation, insects, and rodents perhaps accounting for the overall rapid rate of skeletonization.

6.4.5 CLOTHING

The clothed burials include Nos. 2, 10, and 12. Burial No. 2 (dressed in a fur coat and leather booties) was at the same stage of decomposition as most other non-clothed burials that were observed after 3 months and again after 1 year indicating that the clothing played little role in preservation. This was true also for Burial No. 12 (dressed in a leather jacket) and other experiments approximately 5 weeks after burial. However, at 2 weeks after burial, No. 10 (also dressed in a leather jacket) was less decomposed than the unclothed (No. 11). These results do not support statements that clothing speeds up the decay process (Mann et al. 1990) but supports others that showed clothing slows the decay process (Galloway et al. 1989, Komar 1998). It is also interesting to note the degradation of the modern leather textiles themselves. At 2 weeks after burial the jacket was still in good condition, which is in marked contrast to the 5–week interval when only

the seams of the jacket remained. The leather moccasins on Burial No. 2 were well-preserved after 1 year. Other experiments have shown modern leather to be quite resistant to the burial environment, preserving far beyond 5 weeks (Sorg and Haglund 2002). The preservation of clothing and the role that clothing plays in preservation of the individual likely depends upon whether the body is buried or deposited above ground and the season and corresponding temperature at the time of body disposal.

6.4.6 BURIAL DEPTH

Burials No. 6, 8, and 9 was 10–25 cm were deeper than the average of all other experiments. The depth of Burial No. 7 was 20 cm shallower. Burial No. 7 was at the same stage of decomposition as others observed with it after 3 months and 15 months. Yet, Nos. 6, 8, and 9 (the deeper burials) were all at a more advanced stage of decomposition. All three were skeletonized while other burials observed with them were in an advanced stage of decomposition after 3 months and again after 15 months. In this study deeper burials tended to decompose faster. This does not necessarily conflict with other studies in which deeper burials tend to decompose much slower (Mann et al. 1990) because 50 to 65 cm is still comparatively shallow. It is important to note that in one of these burials the pig was smaller, approximately half the size of the others. Children with relatively small skeletal elements typically go through decomposition processes in a much shorter time interval than adult remains, due in part, to the greater surface-to-volume ratio (Sorg and Haglund 2002). Besides being interred deeper, the other two

burials (Nos. 6 and 8) also had more stones placed on them, which could help to account for their advanced decay. The extra mass overlying the body could have trapped and retained heat longer thereby accelerating decomposition.

6.4.7 FIRE

Burials subjected to fire include Nos. 15 to 20. Those burials that were skeletonized (Nos. 15, 17–19) were exposed to fire for 60–90 minutes less than others that were at an advanced stage of decomposition (Nos. 16 and 20). They also were burned with 3.5 to 8 kilograms less fuel than those at an advanced stage. Typically fire acts as a preservative of skeletal remains by mineralizing the bone. This doesn't explain, however, why the tissues of Burials No. 16 and 20 were so well-preserved. Though half of these experiments were affected by rodent activity, this did not seem to impact decay rates either as pigs in both an advanced and skeletonized stage revealed evidence of rodents.

6.5 CONCLUSIONS

This study provides unique data for a specific forensic burial technique, rock covered, which may provide for estimation of time of death when in the Edmonton, Alberta region. A number of combined factors determine the rate of decay, though some take precedence over others. Weather, insects, and grave type are the most important factors driving rates of decay in this investigation. Aridity and freezing in the winter months combined with warm summer temperatures and wind had a large influence on bodies

buried in this region most often resulting in mummification and skeletonization. Clothing, burial depth, the application of fire, and scavengers also play a role in decomposition rates. Some of the burials (Nos. 1–9 and 15–21) will continue to be monitored through time and changes in stage of decomposition will be recorded.

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7. CONCLUSIONS

7.1 CONCLUSIONS

The principal objective of this study was to examine cultural taphonomic factors associated with mortuary practices at Khuzhir-Nuge XIV (KN XIV) and the ways in which they alter skeletal condition of human remains. Initial investigation of certain aspects of cultural taphonomy at KN XIV was followed by animal analogy experiments in relation to the mortuary use of fire, the mortuary application of red ochre, grave architecture, grave disturbance, and rates of decomposition. Both the archaeological data collected at KN XIV and the experiments have shed additional light on the effects of these cultural taphonomic factors on the condition of skeletal remains, mainly rates of decay, completeness, articulation, and fragmentation.

The results from the investigation of the mortuary use of fire at KN XIV reveals that the application of fire to human remains in the graves was not reserved for a particular group of people but affected both males and females, ages four to over 50, and occurred throughout the entire duration of cemetery use. Observations of visual characteristics of bone and skeletal condition at KN XIV and from the experiments designed to test these observations have answered questions about the technology associated with fire. In particular, the fires at KN XIV were of a relatively low temperature (360°–700°C) and burned for relatively short durations but hotter and longer than those of the experiments (12 or more hours). The source of fuel at KN XIV was likely of the pine or birch family and exceeded 11 kg. The fire seems to have been built over the top of the superior end of the fleshed remains at the west end of the pit and affected the right side of the skeleton

more than the left as a result of the slope of the hill and subsequent position of the person who originally constructed the fire. Stirring or restoking may account for the observed patterns of disarticulation and fragmentation of charred remains at KN XIV. More complete cremations would have required an even larger fire that was possibly augmented with stirring or restoking.

Fire may affect completeness of entire skeletal elements at very high temperatures and/or longer durations of burning but only partial skeletal elements at the temperatures and durations observed among experimental burials. Disarticulation resulting from fire was limited to the slight displacement of ribs. Stirring of the fire would have contributed to further disarticulation. Fire also resulted in some fracturing of skeletal elements. The amount of fractured bone would increase with hotter fires and longer burning. The technology and effects of the outdoor cremation experiments especially with regard to the time and amount of heat necessary to alter skeletal condition provides new and sometimes contradictory insights to the existing literature.

Studies aimed at examination of the taphonomic effect of red ochre are limited in comparison to those that reflect on the symbolic reasons behind its use. Through the examination of red ochre it has been concluded that the ochre at KN XIV is not likely a part of mortuary activity but a consequence of either natural causes or placement of relatively small amounts of ochre in the grave as a grave good. However, in other Cis-Baikal Siberian populations (Kitoi) ochre clearly plays a much larger role. The taphonomic results of ochre have revealed that as little as 2.5 kg of ochre powder will

stain bone prior to 1 year. Ochre does not deter insects or animals, therefore it is not a scavenger deterrent.

Analysis of grave architecture at KN XIV and through experiments revealed that certain aspects may have influenced the state of the remains at KN XIV. The type of grave played a major role in determining the rate of decay and skeletal condition. In particular, those graves that allowed insects and other small animals easy access to the remains experienced more rapid decay, decreased completeness, and movement of bones.

Grave disturbance, examined at KN XIV and through experiments, has helped to classify the types of human disturbance at KN XIV and confirmed that looting likely occurred in many instances. Looting can influence skeletal condition directly in the case of completeness and articulation and indirectly in regards to completeness, articulation, and fragmentation through scavenging of the looted, and therefore open, grave. The effects of looting on skeletal condition depend on whether looters target the graves for known artifacts, simple or complex artifacts, or specific skeletal elements.

More was learned about the looting activity itself and the relative ease at which burials can be tampered with. Looting can be done with relatively few people (1–2), in a relatively short time (possibly over an hour). Looting also alters the shape of the grave in a predictable manner. Looting of the skull may have occurred as soon as 2 weeks after burial.

Disturbances other than looting may have also occurred, e.g. the opening of the grave for the application of fire. Opening of the grave for this, or other similar purposes, may have subjected the burial to further disturbance by animal scavengers.

Finally, the combined experiments have offered unique data for a stone covered burial technique that may provide for estimation of time of death when in the Edmonton, Alberta region. All of the burials in the above studies have shown that it takes 3 to 5 weeks for pigs buried in June at a depth of 40 cm to skeletonize and 5 weeks to 3 months for those interred in May at a depth greater than 40 cm. Weather, insects, and grave type had the largest impact on decomposition. Higher ambient and sediment temperatures correspond to relatively rapid rates of decomposition. Aridity also plays a major role in Edmonton as many of the burials were relatively quickly mummified. Additionally, the potential exposure of the remains to blow flies prior to burial, combined with easy access of blow flies to remains during burial, aided in the rapid decay.

In each of the individual studies (Chapters 2–6), skeletal condition revealed important information about the various cultural taphonomic factors. Major contributions include: 1) a better understanding of the mortuary use of fire and red ochre, and grave disturbance and looting at KN XIV; 2) the technology of fire and its corresponding effects on bone, specifically, the time and amount of heat it takes to significantly alter skeletal condition; 3) the important indirect role that scavenging animals play in influencing various cultural taphonomic factors such as that caused by fire, grave architecture, looting, and the numerous processes associated with decomposition; and 4) the relatively short amount of

time it takes to reach an advanced or skeletonized stage of decomposition in Edmonton, Alberta, given all the observed circumstances associated with decomposition rates.

This research expands the existing data compiled at KN XIV by providing more potential taphonomic variables to be considered in relation to Glazkovo mortuary activities and boreal forest hunter-gatherer lifestyle in general. These variables may be important when examining aspects of mortuary behavior or in the analysis of skeletal remains themselves, e.g. determining the degree to which bone has been burnt when choosing samples for stable isotope ratio, DNA, or radiocarbon analysis. The results from this project also show what can be learned about cultural processes from actualistic experiments and may be applied to taphonomic situations in other regions of both ancient and contemporary contexts.

7.2 FUTURE RESEARCH

Each of the experiments in this study with the exception of Burials No. 11–15, are still in progress and will continue to be monitored including Burials No. 1–4, 6–10, 20–25, and 27 (n=16). Any changes to the graves and burials will be recorded, furthering the examination of cultural taphonomy of human remains. More experimental studies would be beneficial to understanding the mortuary role of fire, specifically constructing larger fires that burn for longer periods. Red ochre experiments using smaller amounts of ochre and ochre in different forms, for example a paste as opposed to powder, are also beneficial. When examining rates of decomposition, more sediment-filled burials with less cultural activity or burial treatments would allow for more concrete forensic data to

be gained. Expanding the regions in which these experiments are carried out would provide better geographical comparisons. Finally, conducting fewer experiments in which there are fewer treatments (no more than one dependent variable), would allow replicated studies to provide more reliable and precise results. Whatever the variable being examined, it is only that variable that should be altered so that it can be scored on a nominal or ordinal scale and compared to other scored data such as temperature or depth of burial.

With regard to continuing research at KN XIV and other cemeteries in the Baikal region investigations of taphonomy should be expanded to include individual and environmental taphonomic factors. Understanding the cultural agents is just one part of the puzzle. A clearer understanding of all three categories of taphonomy at this and other sites is necessary. Research is currently being compiled on aspects of individual taphonomic variables beyond just age and sex, but including aspects of diet, pathological conditions, and stress markers. These attributes need to be examined within a taphonomic framework. Finally, climate and weather data and data on past and present biotic and abiotic indicators should be examined at the level of the site, burial and each skeletal element.

Appendix A: Black=present/uncharred, Red=present/charred, White=absent, Grey=unsided/charred

No. 9 Male, Old Adult

No. 24 Undetermined, Adult

No. 25 Prob. Male, Middle Adult

No. 28 Probable Female, Adult

No. 29 Male, Old Adult

No. 34 Male, Young Adult

Note: Burial No. 82 was represented by only 10 fragments of charred, unidentified long bones.

No. 37.1 Undetermined, 14-17

No. 37.2 Undetermined, 14-17

No. 38 Male, Middle Adult

No. 41 Undetermined,Undeterm.

No. 43 Male, Young Adult

No. 52 Undeterm., Young Adult

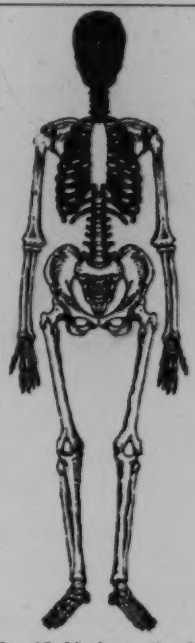
No. 54 Undetermined, Adult

No. 57.1 Female, 18-20

No. 57.2 Prob. Male, Mid. Adult

No. 62.1 Male, Adult

No. 62.2 Undetermined, 8-10



No. 65 Undetermined, 5-6

No. 66 Male, Middle Adult

No. 82 Undetermined, 20-25